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Site Development Services at McGhee Tyson Airport

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Site Development Services at McGhee Tyson Airport Design Report

University of Tennessee, Knoxville
Tickle College of Engineering
Department of Civil and Environmental Engineering
CE 399S & CE 400 Senior Design Course Experience
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Mission Statement

Our mission is to strive to restore and improve urban infrastructure as it relates to the facilities and services necessary for aeronautical operations. We seek to be ambassadors of The University of Tennessee and our community by upholding the values of integrity, discipline, and ingenuity in our design. As students, we are continuously searching for new knowledge to ensure our work stays at the forefront of the industry. Therefore, the designs produced utilize the most up-to-date industry-standard technology and regulations to ensure the designs have a minimal negative impact on the surrounding environment.

Disclaimer

The contents of the following report were assembled by engineering students without constant oversight or approval from a licensed engineer. The report and respective designs were completed for academic purposes only and therefore should not be implemented prior to extensive review of the documentation by a licensed engineer. Neither ACEC, LLC (our student design team) nor the mentors assume any liability for the implementation of the contents of this report.

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Matt Cate, Research Leader I, UTK Center for Transportation Research

Jenny Retherford, Senior Lecturer – Department of Civil & Environmental Engineering

Taylor Kidwell, Nashville Division Manager, CSA

William Scott, Structural Engineer, CSA

Steve Drummer, Senior Civil Engineer, LDA

Stefanie Farrell, Senior Project Manager, LDA

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1.0 INTRODUCTION

ACEC, LLC was contacted by the Metropolitan Knoxville Airport Authority (MKAA) through the University of Tennessee, Knoxville Civil and Environmental Engineering Department's senior design program to develop a new private terminal with airplane storage. MKAA requested the team develop a new site for general aviation practices with amenities for a fixed base of operations in addition to facilities for airplane storage and parking space for employees and the general population.

The purpose of this project is to perform engineering services to allow for an increase in general aviation traffic at McGhee Tyson Airport by making use of current airport property. To achieve this, a current drainage basin will be modified into a site capable of supporting a new airport facility for general aviation activities. A small terminal is needed to support airplane owners and pilots as well as approximately three employees. Parking is requested to accommodate 100 cars for both short term and long-term vehicle storage. Hangar space is needed for 50 Class I aircraft for permanent and temporary storage, and connections to existing infrastructure are needed to smoothly integrate the new project into existing airfield operations.

2.0 EXISTING SITE CONDITIONS

The site for the general aviation expansion, shown in Figure 1, chosen by the airport authority is a small plot of land that is on current airport property. The project site currently serves as a drainage basin to remove runoff from the southwest region of McGhee Tyson's Air Operations Area (AOA). The site currently exists outside of the AOA and is bordered on two sides by a fence line marking that boundary. North and East of the AOA Fence is existing airport infrastructure including a taxiway and a ramp. On the south side of the property are two public county roads which could be used for vehicle access.

Figure 1: Site Location

At the far east side of the project site are four pipe outlets that carry stormwater from the southwest portion of the airfield and a section of Alcoa Highway to the drainage basin. Two nine-foot diameter pipes are conjoined in a double barrel formation with a headwall at the outfall. Both 9-foot pipes have heavy-gauge rebar screens to prevent unwanted persons from entering the pipe. The pipes discharge into a concrete slope, through two rows of energy dissipators, and into a grass and riprap open channel. Another pipe outlet consists of a seven-foot diameter pipe with a similar industrial-grade screen preventing entry, also with a series of energy dissipators at the end of its concrete gradient. A third pipe outlet consists of a five-foot diameter pipe with the same features as the seven-foot pipe. These pipes have concrete open channel flow gradients that conjoin and travel along the concrete pad. The runoff is then discharged to the same open channel as the double barrel configuration so the runoff can flow off site.

The project site extent boundaries currently consist of a diverse set of neighboring conditions. The site is bordered on two sides by a secure AOA fence line. The existing AOA fence, as shown in Figure 2, acts as a secure perimeter separating the controlled area of the airport with direct access to aircraft from the surrounding property. This secure perimeter must be maintained at all times. The southeast side of the site is bordered by private land divided into neighborhood lots. There is a small berm with trees that separates this land from the project area. The fourth side of the project site continues onto adjacent airport property that is not part of the AOA.

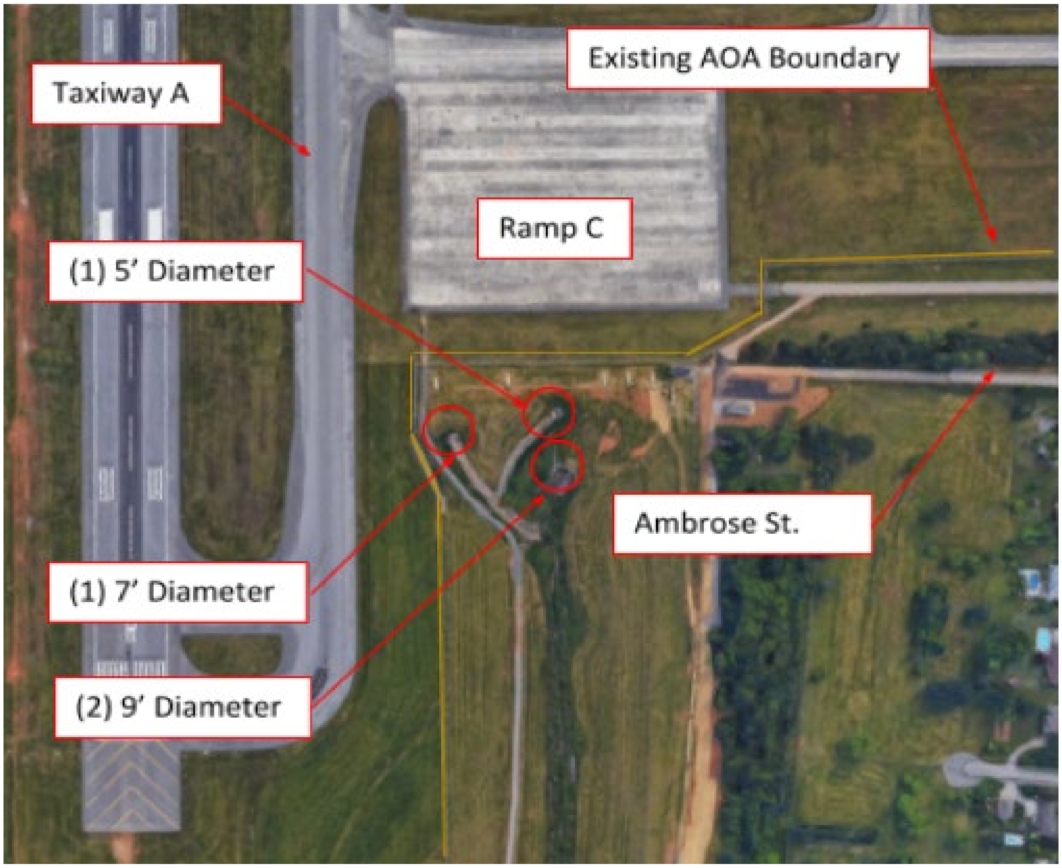

Figure 2: Existing Site Infrastructure

The primary existing airport infrastructure near the site includes Taxiway A and Ramp C. Taxiway A, directly adjacent to the northwest side of the development site, is the closest primary connector to the existing airport infrastructure. In its current state, Taxiway A is about 68 feet above the grade of the lowest point of the development site. Taxiway A is currently used as the primary access route to runway 5R. Ramp C is directly adjacent to the northeast side of the project site. Ramp C is currently used for temporary aircraft storage and pre-takeoff runups.

Vehicle access to the project site is available by two different routes. Primary public vehicle access to the development site is currently provided by Ambrose Street, a two-lane public road to the south of the development site. Ambrose Street currently passes through the neighborhood to the south of the development site before passing through an airport-controlled gate and terminating at the edge of the development site. There is a secondary access route provided by Flagship Knoxville Drive, which connects the project site to the commercial terminal section of the airport property. This route is currently primarily used by airport personnel.

3.0 TEAM AND PROJECT CONTACTS

ACEC, LLC is a group of civil and environmental engineering students (Figure 3) from the Tickle College of Engineering at the University of Tennessee, Knoxville. The team is composed of students focused in four different concentrations within civil engineering including construction, environmental, water resources, and structural engineering. Roles for the project have been assigned based on the contributor's specific concentrations and interests in civil engineering as shown in Figure 4 and Table 1. Each member will coordinate with others outside of their assigned role to create a comprehensive product for the client. The client for this project is the engineering team at McGhee Tyson Airport (see Table 2). Engineering work for this project is being done under the guidance of mentors (Table 2) with professional experience in civil engineering.

Figure 3: ACEC, LLC Design Team (shown from left to right: Luke Edwards, Tyler Bomar, Sam Enders, Matthew Dearborn, Scott Cole)

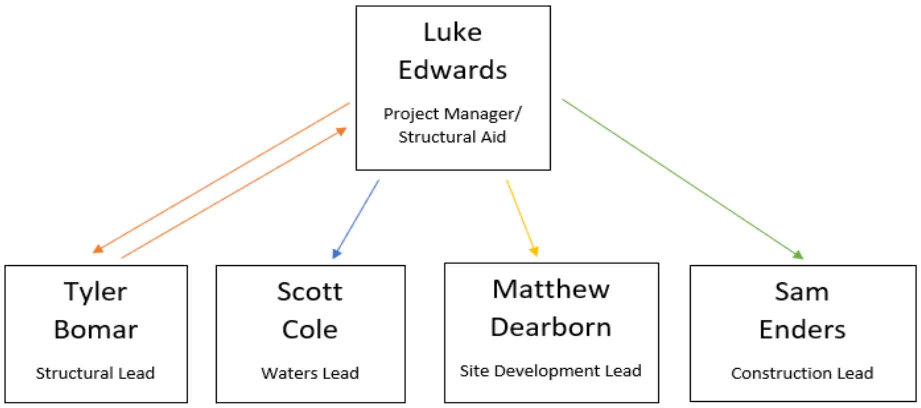

Figure 4: Organizational Chart

Table 1: ACEC, LLC Team Roles and Contacts

NAME	ROLE	PHONE NUMBER	EMAIL
Luke Edwards	Manager/Structural Design	(423) 612-4193	ledwar35@vols.utk.edu
Tyler Bomar	Structural Lead	(618) 977-6973	tbomar2@vols.utk.edu
Samuel Enders	Construction Lead	(919) 441-3686	senders@vols.utk.edu
Matthew Dearborn	Site Development Lead	(615) 339-7275	mdearbor@vols.utk.edu
Scott Cole	Waters Lead	(615) 974-9747	scole31@vols.utk.edu

Table 2: Client and Mentor Affiliations and Contacts

Name	Organization	Email
Bryan White	McGhee Tyson	bryan.white@tys.org
Eric Williamson	McGhee Tyson	eric.williamson@tys.org
Taylor Kidwell	CSA	tkidwell@csastructures.com
William Scott	CSA	cscott@csastructures.com
Steve Drummer	LDA	sdrummer@ldaengineering.com
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Dave Clarke	University of Tennessee	dclarke@utk.edu

4.0 TECHNICAL SCOPE OF WORK

A plot of land at McGhee Tyson Airport was selected to allow for the future expansion of private air-travel operation facilities to include a new parking lot, new terminal and office area, and new hangars and taxilanes for Federal Aviation Administration (FAA) designated Group I jets. Engineering services for this project include site development, stormwater management design, structural design, and construction engineering. Civil site work was completed to design connection to existing infrastructure and develop an efficient layout for the movement of vehicles, pedestrians, and supplies. Stormwater management services are completed to provide adequate drainage accommodating the existing and new site infrastructure. Structural design was completed applying necessary gravity and lateral loading cases and analyzing these cases for proper member and connection design. Foundation design was performed to adequately transfer loads from structural members to the subsurface. Construction engineering services were provided to develop a construction schedule, determine materials quantities, and create an estimate of probable cost.

5.0 CIVIL SITE WORK

Civil site work services included development of a layout for a new parking lot, private terminal, and hangars within the project site. The Federal Aviation Administration's Advisory Circular (FAAAC) was referenced to identify an initial hangar pad layout based on the design aircraft. The dimensions of the parking areas were designed based on Alcoa parking standards and client feedback. The terminal layout was designed for full functionality while occupying minimal space using Autodesk Revit, and changes were made through client feedback. An initial site plan was developed and iterations were performed to maximize the distance of the new development from existing community neighbors. Once the layout was finalized, a roadway extension was designed to provide access to the new facilities and future expansions. Blast shields were specified at specific locations around the hangar pad to protect the hangars from activities performed on Ramp C and Taxiway A.

The guidelines set by the Advisory Circular (FAAAC) were used in the design for hangar pad spacing. Dimensions of the cirrus jet allowed the aircraft to be placed in an airplane design group to determine taxiway and taxilane separation criteria as shown in Table 3. The taxiway centerline to a parallel taxiway centerline criterion was met by aligning the designed hangar pad with the adjacent Ramp C. The minimum distance requirement from a taxilane centerline to a fixed or movable object was met by increasing the distance between the rows of hangars. Upon determining these values, a hangar pad layout with three rows of 16 hangars each was designed, resulting in a 700' by 440' concrete pad for hangar placement.

Table 3: Taxiway/Taxilane Separation Criteria

Parameter Name	Requirements	Final Values
Tail Height	<20 ft	10.9 ft
Wingspan	<49 ft	38.7 ft
Category	Group #	Group 1
Taxiway Centerline to Parallel Taxiway Centerline	70 ft	150 ft
Taxilane Centerline to Fixed or Movable Object	39.5 ft	40 ft
Taxilane Width	79 ft	80 ft

The dimensions of the parking lot were set based on requests from the client and parking lot standards set by the city of Alcoa. The parking layout was determined based on design vehicle dimensions and offering maximum secured and unsecured parking spaces. The evaluation was an iterative process and multiple configurations were considered (see Appendix A) before the final design was determined. The design was finalized with 45-degree parking spaces, allowing easier access to the spaces for the larger vehicles. Due to the change to a 45-degree angle design, it was determined that a standard two-way lane used in standard parking lot layout was not required for the development's parking lot. All of the dimensions for the parking area were determined based on standards set by the city of Alcoa, which are shown below in Table 4.

Table 4: Parking Lot Design Parameters

Parameter Name	Parameter Value
Aisle Width	12 ft
Stall Length	18 ft
Stall Width	9 ft
Parking Area Width	50 ft

The terminal layout was designed considering the volume of people likely to be at the terminal at any given time. The total size of the terminal was designed to be approximately 1600 square feet with the main entrance leading to the front desk and lobby. Initial layout of the building included a storage closet, a unisex bathroom, a secure door to the AOA, and a door to the air planning office all accessible from the airport lobby. The office has a cubical space for six employees, a private office, and space for a conference table. After consultation with the client, it was determined that another bathroom was required to fulfill the goals of the terminal's design, so the original size of the bathroom was reduced to make room for a second to be placed adjacent to the other. The components discussed above were used solely to estimate the size required for the terminal to meet the project needs and are shown in the construction drawings but require the design and approval of an architect for the finalized interior layout.

Site work performed for this project included the design of the new development at the maximum possible distance from the nearest property boundaries to minimize negative community impact. The site was originally laid out with two rows of 25 hangars each and was roughly 1500 feet long. The private terminal was designed to be minimalistic to accommodate for the intended volume of the space. To further reduce project space, the 100-space parking lot was designed to surround the terminal with spots on either side and in the front, creating a larger buffer between the surrounding residents. This site design extended closer to the neighborhood than desired, requiring an alteration of the hangar pad length. The developed alternative was the design of three rows with 16 hangers each while still meeting taxiway and taxilane requirements. This iteration left available space for the original terminal and parking lot design while reducing the negative impact on the surrounding areas. Changes to the site plan also required an iteration of the AOA fence line relocation. The new AOA fence will run along the north edge of the developed terminal to ensure visitors must pass through a security checkpoint to enter FAA regulated space. The remainder of the fence will run along the outer edge of the developed hangar space and tie into the existing fence near Taxiway A.

Development of the site requires a roadway connection to existing infrastructure on adjacent airport property. The parking area will be accessed directly via an updated connection through a newly developed roadway. Due to the development being further south than Ramp C, existing roadways are intruding on the development design. Ambrose Street needs to be shortened by approximately 200 ft, and the existing connection to Flagship Knoxville Drive shall be removed. A new street connecting the two roads perpendicularly will continue to the parking lot entrance. Changes in the roadway design require the addition of stop signs at the end of Ambrose Street and at the southbound intersection of Flagship Knoxville Drive. The estimated volume of 50 veh/day does not meet the MUTCD warrant criteria of 80 veh/hr, but signage is included in the design to prepare for higher traffic volumes in the future. The dimensions of a low-volume local road must meet minimum requirements for the safety of drivers. The AASHTO Greenbook was used to determine the roadway dimensions and other design requirements for low-volume local roads which are displayed in Table 5. The lane width and shoulder width were selected based on Greenbook roadway design standards. The speed limit and stopping sight distance for signage were selected based on the estimation of daily traffic. The proposed sign dimensions were selected based on the Manual on Uniform Traffic Control Devices (MUTCD) design criteria.

Table 5: Roadway Parameters

Parameter Name	Parameter Value
Lane Width	11 ft
Shoulder Width	2 ft
Traffic Volume	50 veh/day
Speed Limit	25 mph
Stopping Sight Distance	200 ft
Sign Dimensions	30" x 30"
Calculated Horizontal Curve Radius	62 ft
Design Horizontal Curve Radius	90 ft
Total Volume of Asphalt	3,777 cubic ft

The addition of blast shields around the hangar pad is highly recommended due to Ramp C being within 100 feet of the development. Many types of planes perform activities on Ramp C that create jet blast in the direction of the hangars. For this reason, six blast shields were included on the northeastern side of the pad to reduce incoming jet blast and their effect on other aircraft in the vicinity. The G14M-3 model blast deflector from Blast Deflectors Inc. was selected for the development. This model is a curved deflector that protects all aircraft from jet blast with a height of 14 feet and a base depth of 9 feet. The height of the shield was selected to be the approximate height of the hangar to help also help mitigate the effect of jet blast on the hangars. Blast shields were placed along the entire 700-foot length of the pad adjacent to Ramp C to ensure maximum coverage and protection from jet blast as shown in the construction documents.

6.0 STORM WATER CONSIDERATIONS

Stormwater services provided for the site include the evaluation of the preexisting infrastructure and geographic features, determining the existing hydrological parameters, determining the design parameters, and performing an iterative design process to create a new stormwater management system. An inventory of the site's existing features was performed to determine the size, location, and the intended design function of the site's infrastructure. The hydrological and rainfall parameters were identified for the existing site features, such as storm frequency, storm duration, storm intensity, runoff coefficient, and soil type. Initial design parameters such as peak flows, pipe sizes and lengths, invert elevations, velocities, and storage requirements were identified to create a concept system, and an iteration was performed to design a new stormwater management system.

The preexisting features of the site were inventoried to determine the location, size, and type of infrastructure and geographic features. Four outfalls were identified that discharge into a drainage ditch through McGhee Tyson Airport provided contour data and existing stormwater plans. The drainage ditch is identified by the McGhee Tyson Airport Airfield Stormwater Management Manual as the south lateral ditch. Table 6 shows the sizing, length, and invert elevation of each pipe that discharges into the south lateral ditch. Through the airport's existing stormwater plans, it was found that a 60" RCP extends along the south side of Taxiway A. An 80" RCP extends Southwest of Ramp C and is conjoined by a manhole that connects it to two pipes. One of these pipes extends between Ramp C and Taxiway A, and the other extends towards the maintenance facility southwest of the manhole junction box. Two 108" RCPs extend between Ramp C and Taxiway A, and they are met with a drainage basin at the surface that is fed from another series of 108" RCPs that run the length of Taxiway A. The McGhee Tyson Airport Airfield Stormwater Management Manual indicates that the south lateral ditch provides an area of infiltration to prevent ponding near Taxiway A. The length of the south lateral ditch was found as well as the elevation difference and is shown in Table 7 by using the Airport's topographic data. to be 2,344 feet long with a 60 feet elevation difference, by using the airport's topographic file. During a site visit, energy dissipators were identified located on the 9-foot pipes' outfall and throughout the south lateral ditch.

Table 6: Pipe Extension Sizes and Length

Pipe Sizing (inch)	Length (feet)	Invert Elevation (feet)
60 RCP	820	910
80 RCP	455	905
108 RCP North	877	885
108 RCP South	877	885

Table 7: South Lateral Ditch Data

South Lateral Ditch Length (feet)	South Lateral Ditch Elevation Difference (feet)
2344	60

Hydrological and rainfall parameters were determined for the site, such as, storm duration, storm intensity, runoff coefficients, watershed areas, and soil type for the pre-existing site's infrastructure. The Knox County Tennessee Stormwater Management Manual was used to determine the design storm. Per mentor guidance and TDOT standard design criteria, the storm duration was selected for 0.33 hours. The McGhee Tyson Airport Airfield Management Masterplan (MTAASMM) was referenced for selecting the storm frequency. Based on the identified storm duration and frequency, the storm intensity was determined using the Knox County Tennessee Management Manual shown in Table 8 in Appendix B: Water Resources calculations. The Knox County Tennessee Stormwater Management Manual, Table 3-7 in Appendix B, was also referenced to determine the runoff coefficient along with the MTAASMM. The watershed areas were determined by using McGhee Tyson Airport's water and utility drawings to determine the area that the existing pipes were collecting runoff from. Once the general vicinity of the watershed was identified, Google Earth was used to quantify the watershed area which can be seen in Table 9 along with the previously discussed parameters in this paragraph. The MTAASMM provided the soil conditions and type of soil found throughout the airfield.

Table 8: Existing Site Infrastructure Design Parameters

Parameter Name	Value
Storm Frequency	10 year
Storm Duration	0.33 hour
Storm Intensity	4.1 in./hr
Runoff Coefficient	0.86
5 - Foot Pipe Watershed Area	10.42 acres
7 - Foot Pipe Watershed Area	28.02 acres
9 - Foot Pipe Watershed Area	67.25 acres
Soil Type	NRCS Group C

Table 9: Watershed Areas

Pipe Identification	Watershed Area (ft^2)
60" RCP	10.42
84" RCP	28.02
108" RCP	67.25

Initial design parameters, peak flow of proposed pipes, pipe sizes and lengths, invert elevations, velocities, and required storage volumes were determined as part of the iterative design process to create a new stormwater management system. Based on the rainfall data found, the peak flows for the existing pipes were found using the rational method, Equation 1-0, recommended by the Knox County Tennessee Stormwater Management Manual shown in Appendix B: Water Resources Calculations. The flows of the proposed extended pipes are shown in Table 10. The pad required a drainage system to prevent flooding in the hangars, so the pad was designed to have a separate series of pipes that tied into the proposed extended pipes. The peak flow of the pipes located on the pad were determined using the same data as the proposed extended pipes and are shown in Table 11. To conform with the existing infrastructure, the extended proposed pipes were sized to match the existing sizes. However, sizing calculations were performed to ensure that the minimum size requirements were met. Equation 7-4 from the Knox County Tennessee Stormwater Management Manual, shown in Appendix B: Water Resources Calculations, was used to determine the minimum pipe size for each proposed pipe. Shown in Table 12 are the proposed extended minimum pipe sizes. The 84" RCP and the 60" RCP were designed to combine in a manhole and discharge into an 84" RCP. The 108" RCP pipes were extended into two manholes to redirect the flow to the desired outfall location. The lengths of the extended pipes were designed in Civil 3D to discharge at the base of the required 6:1 slope and are shown in the pipe table on C-104. The proposed pipes on the pad were sized using the same data and method and are shown in Table 13. The pipes on the pad were designed to act as trench drains that start at the first hangar and run to the end of the last hangar of each row and flow bidirectionally to the center of the lane between the hangars. The lengths of the pipes on the pad were designed in Civil 3D and are shown in the pipe table in drawing C-104. The Invert elevations for each pipe in the network were determined in Civil 3D to conform with the finished grade surface. The invert elevations for each pipe can be found in drawing C-104. Per the Knox County Tennessee Stormwater Management Manual, the minimum velocity for water flowing through pipes cannot be less than 2.5 feet per second. Using Equation 1-1 in Appendix B: Water Resources Calculations, the velocities for each pipe was calculated and are shown to conform with the requirement. Erosion control at the end of the headwall of the proposed network was addressed by putting several rows of energy dissipators at the base of the headwall structure. To prevent ponding along the south lateral ditch, storage berms were designed to be placed at the outfall of the proposed stormwater management system. Equation 2-2 shown in Appendix B: Water Resources Calculations was used to calculate the amount of required storage in feet-acre. The required storage capacity for each pipe is shown in Table 14.

Table 10: Proposed Extended Pipe Peak Flow Data

60" RCP	18.79 CFS
84' RCP	50.54 CFS
Combined 84" RCP	69.32 CFS
Double 108" RCP	121.32 CFS

Table 11: Pad Drainage Pipes Peak Flow Data

Total Pad Flow	27.07 CFS
Pad Drainage Pipe 1	6.76 CFS
Pad Drainage Pipe 2	6.76 CFS
Pad Drainage Pipe 3	6.76 CFS
Pad Drainage Pipe 4	6.76 CFS
Connection Pipe Between 1 and Manhole	6.76 CFS
Connection Pipe Between 2 and Manhole	6.76 CFS
Connection Pipe Between 3 and 4 to Manhole	13.52 CFS

Table 12: Proposed extended Pipe Data

Pipe Identification	Minimum Size Requirement (feet)	Design Size (Feet)	Velocity (Feet/Second)
Pipe 35	2.86	9	7.63
Pipe 36	5.46	9	7.63
Pipe 44	2.77	9	7.63
Pipe 45	2.85	9	7.63
Pipe 43	2.15	7	7.21
Pipe 43(1)	1.73	7	7.21
Pipe 42	1.94	7	5.26
Pipe 40	1.14	5	3.83

Table 13: Minimum Pad Pipe Sizes and Design Sizes

Pipe Identification	Minimum Size Requirement (ft)	Design Size (ft)	Velocity (ft/s)
Pipe 35	1.06	2	4.31
Pipe 48	1.08	2	4.31
Pipe 48(1)	0.57	2	8.62
Pipe 54	0.57	2	8.62
Pipe 49	1.07	2	4.31
Pipe 49(1)	1.07	2	4.31
Pipe 53	1.09	2	17.24
Pipe 50	1.05	2	4.31
Pipe 50(1)	1.08	2	4.31
Pipe 57	0.84	2	8.62
Pipe 56	1.06	2	4.31
Pipe 56(1)	1.08	2	4.31

Table 14: Required Storage

60” RCP	35 (Acre Feet)
84” RCP	97 (Acre Feet)
Double 108” RCP	232(Acre Feet)
Pad Drainage	52 (Acre Feet)
Total Storage	416 (Acre Feet)

7.0 STRUCTURAL DESIGN

Structural engineering services provided for the general aviation expansion at McGhee Tyson include the analysis and design of a new terminal, three rows of 16 T-shaped hangars, and two parking covers. The structural member layout was completed to ensure minimal impact in the occupiable and surrounding space to allow for variability of architectural design. The city of Alcoa currently adopts the International Building Code 2018 (IBC 2018) which was referenced to identify gravity loads applied to each structure. Lateral loads considered in analysis and design included both seismic and wind load conditions calculated in accordance with ASCE 7-16. Structural analysis and design performed using RISA 3D, was completed to evaluate internal forces for all structural members and select appropriate member sizes based on LRFD limit state criteria, refined based on economy defined by member weight. Member to member connections were designed using RAM Connection and were in agreement with internal member forces obtained from the RISA 3D model.

Structural member layout for the terminal, hangar, and parking cover was developed to minimize interference with the space contained by or surrounding each structure and to establish the framing plan for the structure. To maximize architectural flexibility for the interior of the terminal, structural framing was placed inside the exterior walls with the top of steel at an elevation of twelve feet to create an open space with no internal load bearing structures (as fully expressed in the accompanying engineering drawings). Columns are located at the end of each beam and placed in each of the four corners of the structure with two intermediate columns in the north and south exterior walls. Hangar structural framing layout was designed similarly to allow open space inside each unit and the installation of a 46-foot-wide hangar door. The bays between each door were identified as moment frames to resist lateral loads along the length of the hangar. To resist lateral loads along the width of the hangar, moment frames were developed by placing the columns along the interior unit walls to minimize interference with the open space. The parking cover was designed using a system of beams and cantilever girders. Load bearing beams frame into the end of each cantilever girder which transfers the load into the cantilever columns and into the subsurface. The cantilever columns were placed between parking spaces to minimize interference with the parked vehicles. Each structure utilizes prefabricated Vulcraft structural steel joists with Vulcraft steel decking to transfer the roof load into the framing of each structure. Spacing between joists were maximized based on the maximum clear span between supports for the steel decking to reduce the quantity of joists required per structure. The design of the three unique structures allows for variability in architectural design and minimizes interference with open spaces.

Gravity loads were determined and applied to each of the three unique structures to establish initial stable conditions and a preliminary design concept. The gravity loading cases found to be relevant to the design of all structural members were dead loads and roof live loads as shown in Table 15. With no architectural plans submitted, an all-inclusive dead load was applied to each structure to account for the weight of MEP, finishing materials, and to allow for variations to be made to the structure that would not significantly affect individual structural components. The roof live load was consistently applied to all structures and was not reduced per ASCE 7-16 due to the assumed shallow slope of the roof. Loads were applied to load bearing members as line loads calculated based on the tributary area of each beam and were transferred to columns or girders by shear or moment connection. Initial sizes were chosen and iterated to determine efficient member sizes using RISA 3D based on applied loads, deflection, and individual capacities. Design of structural steel joists utilized the previously determined center to center spacing to determine the tributary width of each member and the total load applied along the length. The load was used along with the length of the joists and the Vulcraft design tables to select efficient joist sizes for each member. The initial application of gravity loads resulted in final sizes for gravity members and preliminary sizes for lateral members that satisfied the gravity conditions.

Table 15: Live Loading Cases

Loading Case	Uniform Loading (psf)
Roof Live Load	20
Dead Load	20
Hangar Door Load (Dead Load)	5

Calculations for seismic loading followed the Equivalent Lateral Force Procedure outlined in ASCE 7-16. Seismic loading parameters utilized the data provided by the Applied Technology Council (ATC) to obtain more accurate values than the code was able to provide which are noted in Table 16. The terminal and hangers utilized steel ordinary moment frames while the parking cover was designed as a steel ordinary cantilever column system with calculation values noted in Table 17. Initial member sizes based on gravity loads allowed for an approximation of seismic weight to be calculated and used in the calculation of the base shear of each structure. The seismic response coefficient was calculated separately for each structure, as shown in Appendix C, to determine the individual values of base shear which is noted in Table 18. A redundancy factor of 1.0 was used in the calculation of base shear for each structure. The calculations resulted in the applicable lateral load for each structure for seismic parameters.

Table 16: Seismic Loading Parameters

Parameter	Value
Risk Category	II
Importance Factor (Ie)	1.0
Site Class	D
Mapped Spectral Response Parameters	
S_s	0.893
S_1	0.16
Design Spectral Response Parameters	
Sd_s	0.68
Sd_1	0.243

Table 17: LFRS Design Values

	Terminal LFRS	Hangar LFRS	Parking LFRS
Response Modification Coefficient (R^a)	3.5	3.5	1.25
Overstrength Factor (Ω_o)	3.0	3.0	1.25
Deflection Amplification Factor (C_d^b)	3.0	3.0	1.25

Table 18: Seismic Base Shear

Base Shear	Kips
Terminal	3.65
Parking Cover	20.79
Hangar	106.55

Calculations for wind loading followed the procedures as defined in ASCE 7-16. Wind loading parameters for the site development area were used to determine variables for wind loading calculations; these parameters are shown in Table 19. The wind loading parameters were used for each structure to calculate windward and leeward wind pressures. Pressures are dependent on the classification of the structure's percent of open surface area. The terminal is classified as enclosed; the parking cover is classified as open; the hangars are classified as partially enclosed. Final windward, sidewall, and leeward pressures applicable to each structure as well as the roof pressure for the parking structure are shown in Table 20.

Table 19: Wind Loading Parameters

Parameter	Value
Risk Category	II
Ultimate Wind Speed	105 MPH

Table 20: Wind Loading Pressures

Terminal	Values
Windward Pressure	-12.6 lb/ft^2
Leeward Pressure	14.4 lb/ft^2
Parking Cover	
Roof Pressure	-16.2 lb/ft^2
Hangar	
Windward Pressure	17.26 lb/ft^2
Leeward Pressure	-10.79 lb/ft^2
Sidewall Pressure	-15.10 lb/ft^2
Roof Pressure	-19.41 lb/ft^2
Internal Pressure	± 11.86 lb/ft^2

Determination of the lateral loads for each structure allowed for the finalization of member sizes and load paths by including the effects of all applicable loading scenarios. Seismic and wind loading scenarios for the terminal and parking cover were applied directly into the diaphragm while the lateral loads for the hangar were applied to individual walls due to the determination of the structure being classified as partially enclosed. The preliminary member sizes were iterated in RISA 3D using a batch solution to ensure worst case member forces and deflections were considered due to the application of lateral loads. Code check was used to ensure individual member capacities were not exceeded. Members that exceeded loading capacities were iterated to ensure a safe and efficient size. Deflections for occupiable spaces such as the terminal and hangars were limited to L/360 while a deflection limit of L/240 was utilized for the parking cover. Beams that exceeded deflection limits were increased in depth to increase the moment of inertia and therefore decrease deflection. Application and iteration of the structures applied with all applicable loading scenarios resulted in a feasible structure that would ensure the safety of the occupants as shown in the construction documents.

Member connections were designed following shear and moment connection assumptions developed during load path determination. Shear connections were designed using weld-bolted connections to ease in constructability due to the difficulty in tightening bolts inside HSS columns. Moment connections were designed as two main types; a column cap with the beam on top of the column and a moment connection attached directly to the side of the column. Required loads for connections utilized the maximum forces determined using the RISA 3D model and were designed to ensure compliance with code using RAM Connection. Members that were not in compliance with code were typically due to the thickness of the wide flange web or wall of HSS. These members were updated in size and reanalyzed in RISA 3D to determine new connection requirements. Design of connections for similar members were designed using the worst load case for the repetitive member to ease in constructability for each structure by creating a repetitive connection process. Final connections are presented in Appendix C and the construction documents and are intended to offer feasible, constructable structures.

8.0 FOUNDATION DESIGN

Foundation design services provided for the general aviation expansion at McGhee Tyson is done performing geotechnical analysis and design to size foundations to safely transfer loads from site structures to the subsurface. Structural fill material was specified for the site to meet suitable criteria for the foundation. Baseplates and anchor bolts for columns were designed in accordance with the AISC Steel Manual and ACI-318 Code. A shallow foundation system was designed, using RISA Foundation, based on the soil fill strength characteristics and loads determined from the RISA 3D structural model.

Structural fill material has been specified for the site to adequately meet criteria based on the foundation soil requirements. Because fill material for the site was not tested for foundation design, assumptions have been made for fill soil classification, soil parameters of strength, and fill construction methods. These assumptions are based on chapter 18 of IBC 2018 and soil classification based on ASTM D2487. Structural fill soil is specified as sandy gravel and gravel compacted to 95% of standard proctor. Soil strength parameters can be assumed based on this choice of soil classification, as shown in Table 21. Upon construction, a geotechnical investigation is required to confirm fill compliance with assumed values.

Table 21: Soil Parameters

Soil Classification	GW and/or GP
Compaction	95%
Allowable Vertical Bearing	3 ksf
Lateral Bearing Pressure	0.2 ksf/ft below surface
Coefficient of Friction	0.35
Cohesion	Negligible
Subgrade Modulus	100 k/ft^3

Base plate and anchor rod design for each footing was done in accordance with the design methods set out in the second edition of the *AISC Steel Design Guide: Base Plate and Anchor Rod Design*. Pin connections were designed as concentric axial compressive loads, and moment connections were designed as base plates with large moments. Anchor rods were uniformly chosen to be ¾" ASTM F1554 Grade 36 rods in accordance with Section 2.7 of the referenced steel design guide. Base plates have been designed as ASTM A36 plates. Plate area is based on column sizing. Anchor rod length is based on required development and OSHA requirements as shown in Appendix D. Grout spacing has been designed as two inches with a specified grout design compressive strength of no less than 8000 psi.

RISA Foundation was used to analyze the geotechnical and structural limit states for the design of shallow foundations. Soil limit states included bearing and shear failure of the subsurface as well as serviceability limit states of elastic deformation and immediate earthwork settling. Soil limit states were not considered based seismic concerns such as liquefaction because the specified structural fill soil classification is not susceptible to these limit states. Structural limit states for footings included flexural strength, one-way shear strength, and two-way shear. To increase uniformity of foundation design, all foundations were designed as square spread footings, except for blast shield foundations, which were designed as mat slabs. Additional details for blast shield mat slab foundations are provided in Appendix D and the construction documents. Minimum footing depth below surface grade was uniformly chosen to be 3 feet to assure the footing base was below frost depth. Concrete for footings was chosen to be 4000 psi normal weight concrete. Footings were designed without pedestals except for the parking cover which includes footings designed to include two-foot deep, eighteen-inch square pedestals based on base plate and anchor rod sizing for the structure. A footing schedule was created based on (3) column types: edge, corner, and center and maximum loads from each of these column types were used to size the family of footings applicable for the specific type, as seen in Table 22 and the construction documents.

Table 22: Footing Sizing

	Column Type	Footing Size
Hangar	Edge	9'-6" x 9'-6"
	Corner	6'-6" x 6'-6"
	Center	7'-6" x 7'-6"
Terminal	Edge	6'-0" x 6'-0"
	Corner	6'-0" x 6'-0"
Parking Cover	All	8'-6" x 8'-6"

9.0 CONSTRUCTION ENGINEERING SERVICES

The construction engineering services include estimation of cut and fill quantities for the project, development of a construction schedule for the proposed hangars and office space, and preparation of an estimate of probable cost. The cut and fill volumes were determined using existing contours provided by McGhee Tyson and the new proposed grade. The construction schedule was determined using schedules from projects at the airport and a construction phasing plan and schedule was created using the critical path method. The cost estimation was created using the TDOT pricing sheets, along with the quantities of materials from RISA, AutoCAD, and Revit to provide accurate estimations for the probable cost.

The construction engineering services determined the amount of fill volume needed for the site using the average end area method and the contours for existing and proposed grade. Airport guidelines require a maximum 6:1 slope which will be implemented in the area surrounding the proposed site. The elevation of the pad will gradually slope at the required grade until it ties into the existing grade as shown in the construction ready documents. The proposed grade will maintain the current runoff direction to allow water on the proposed soil surface to be alleviated from the site. Development of the proposed grade allowed for a comparison of surfaces which resulted in total cut and fill quantities using Civil 3D as seen in Table 23. A net quantity of soil was found using the cut and fill quantities to determine the volume of fill material required for the site. To alleviate the quantity of soil required from external sources, the infield of the site was examined for excess soil. It was determined that the excess soil on site, as shown in Table 23, was found to be insufficient in filling to the proposed grade, as shown in Appendix E, and will require the purchasing of soil that meets the design criteria based on structural fill requirements for foundations.

Table 23: Cut and Fill Volumes of Proposed Grade

Cut	8143.71 yd^3
Fill	272239.40 yd^3
Net	264095.69 yd^3
Soil on Site	26535.27 yd^3

Once the site is filled and compacted, the foundation of the buildings will be made of concrete that will allow for the hangars and terminal to tie into the foundation. The alley between the hangars includes a drainage ditch to help keep water from running into the hangars. This ditch will run into the new stormwater system and empty at the same point as the other sections of new stormwater drainage. The primary slab that the three rows of hangars will be placed on will be constructed of asphalt. All asphalt for the hangar area and parking area will be poured after all structures are completed.

Estimations of project duration were completed using schedules of old projects provided by the airport. Determination of the schedule required an inventory of all tasks required for the project and identification of which tasks could occur simultaneously. For example, it was determined that construction of the roadway and individual structures could occur simultaneously to reduce the project construction time. Durations were based on individual items offered by the airport and used to estimate duration based on the development's needs. The critical path for this project has been used to best approximate project duration as shown in Appendix E, with adjustments made to account for delays due to weather, material backordering, and the project's proximity to a major transportation hub, which could experience delays due to its scheduled events and heightened security needs. The total project duration required for completion of all construction tasks was determined from the critical path to last 291 business days. Required permitting and information for each permit required for various construction tasks have been included in Appendix E to ensure compliance with the city of Alcoa.

Construction methods for the development require a wide array of large-scale machinery as well as small scale tools and technology. Throughout the construction, survey equipment is required, including a total station and prism rods, to ensure proper placement of developed infrastructure. The machinery required to grade the proposed surface of the development to the specified elevations presented in the construction documents includes track hoes, hauling trucks, sheepsfoot rollers, smooth drum rollers and bulldozers. Once the earthwork is complete, the equipment needed on site includes cranes for the construction of the hangars and cement trucks for the foundation and taxiways.

Determination of the total project cost referenced TDOT's price reference sheet to determine the cost of material quantities and tasks. Project quantities were determined by performing quantity take offs of individual quantities to obtain an accurate estimation of materials used in the construction process. The quantities were then referenced to TDOT's prices using region one as the basis for cost determination and were multiplied by the base quantity to determine the price of each individual quantity. Upon calculation of the cost of each individual material, the total project cost was determined through the summation of each material cost resulting in the costs shown in Table 24.

Table 24: Cost Estimation

Concrete	$2,836,407.64
Roadways	$683,637.53
Land	$2,575,728.50
Steel	$4,088,492.39
Total	$10,184,266.06

10.0 CONCLUSION

Engineering services have been provided in order to develop a plot of land at McGhee Tyson airport to allow for future expansion of general aviation practices. Site development, stormwater management design, structural design, and construction engineering services have been provided to adequately prepare this project for construction. Civil site work was completed to properly tie in existing infrastructure to the new development and offer the requested amenities for plane storage and access. Stormwater management design has been completed to provide adequate stormwater control on the site using new and existing stormwater infrastructure. Structural design and geotechnical design services have been completed to properly determine loading on new structures, effectively support those loads through steel structural frames, and safely transfer them to the subsurface through shallow reinforced concrete foundations. Construction engineering services have been completed to provide a construction schedule, takeoff quantities, and an estimate of probable cost. Final completion of this project is projected to be accomplished for $10.2 million with a duration of 291 working construction days.

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Appendix A: Civil Site Work

Hangar Pad Standards

<u>Airplane Design Group:</u>

Grouping Requirements:

Table 1-2. Airplane Design Group (ADG)

Group #	Tail Height (ft [m])	Wingspan (ft [m])
I	< 20′ (< 6 m)	< 49′ (< 15 m)
II	20′ - < 30′ (6 m - < 9 m)	49′ - < 79′ (15 m - < 24 m)
III	30′ - < 45′ (9 m - < 13.5 m)	79′ - < 118′ (24 m - < 36 m)
IV	45′ - < 60′ (13.5 m - < 18.5 m)	118′ - < 171′ (36 m - < 52 m)
V	60′ - < 66′ (18.5 m - < 20 m)	171′ - < 214′ (52 m - < 65 m)
VI	66′ - < 80′ (20 m - < 24.5 m)	214′ - < 262′ (65 m - < 80 m)

Tail Height: <20’
Wingspan: <49’
Airplane Design Group: Group 1

Design Standards for Airplane Groups:

Taxiway Separation Values:

Table 4-1. Design standards based on Airplane Design Group (ADG)

ITEM	DIM (See Figure 3-26)	ADG					
		I	II	III	IV	V	VI
TAXIWAY PROTECTION							
TSA	E	49 ft (15 m)	79 ft (24 m)	118 ft (36 m)	171 ft (52 m)	214 ft (65 m)	262 ft (80 m)
Taxiway OFA		89 ft (27 m)	131 ft (40 m)	186 ft (57 m)	259 ft (79 m)	320 ft (98 m)	386 ft (118 m)
Taxilane OFA		79 ft (24 m)	115 ft (35 m)	162 ft (49 m)	225 ft (69 m)	276 ft (84 m)	334 ft (102 m)
TAXIWAY SEPARATION							
Taxiway Centerline to Parallel Taxiway/Taxilane Centerline [1]	J	70 ft (21 m)	105 ft (32 m)	152 ft (46.5 m)	215 ft (65.5 m)	267 ft (81 m)	324 ft (99 m)
Taxiway Centerline to Fixed or Movable Object	K	44.5 ft (13.5 m)	65.5 ft (20 m)	93 ft (28.5 m)	129.5 ft (39.5 m)	160 ft (48.5 m)	193 ft (59 m)
Taxilane Centerline to Parallel Taxilane Centerline [1]		64 ft (19.5 m)	97 ft (29.5 m)	140 ft (42.5 m)	198 ft (60 m)	245 ft (74.5 m)	298 ft (91 m)
Taxilane Centerline to Fixed or Movable Object		39.5 ft (12 m)	57.5 ft (17.5 m)	81 ft (24.5 m)	112.5 ft (34 m)	138 ft (42 m)	167 ft (51 m)
WINGTIP CLEARANCE							
Taxiway Wingtip Clearance		20 ft (6 m)	26 ft (8 m)	34 ft (10.5 m)	44 ft (13.5 m)	53 ft (16 m)	62 ft (19 m)
Taxilane Wingtip Clearance		15 ft (4.5 m)	18 ft (5.5 m)	22 ft (6.5 m)	27 ft (8 m)	31 ft (9.5 m)	36 ft (11 m)

Taxiway Centerline to Parallel Taxiway/Taxilane Centerline: 70 ft
Taxiway Centerline to Parallel Taxiway/Taxilane Centerline Design: 150 ft

Taxilane Centerline to Fixed or Movable Object: 39.5 ft
Taxilane Centerline to Fixed or Movable Object Design: 80 ft

Parking Lot Standards:

Aisle Widths for One-Way Traffic

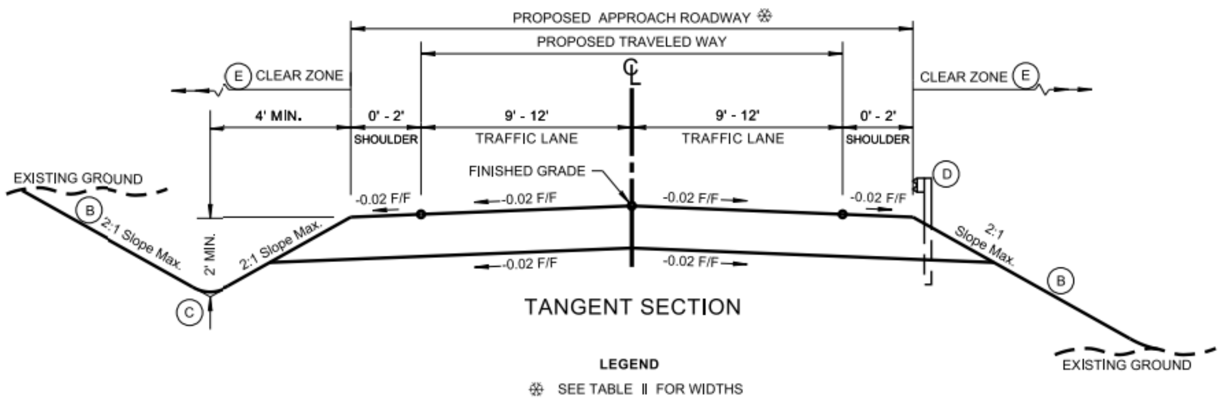
Traffic Circulation	Parking Angle	Aisle Widths
One-way traffic	90 degree parking	18 feet
	60 degree parking	12 feet
	45 degree parking	10 feet
	30 degree parking	10 feet
Two-way traffic	90 degree parking	25 feet
	60 degree parking	20 feet
	45 degree parking	20 feet
	30 degree parking	20 feet

Traffic Circulation:	One-way traffic
Parking Angle:	45 degree parking
Minimum Aisle Width:	10 ft

Roadway Design and Standards:

<u>Roadway Design for Low-volume Local Roads</u>

Cross Section Standards:



Traffic Lane Width: 11 ft
Shoulder Width: 2 ft

<u>Design Speeds for Low-volume Roads</u>

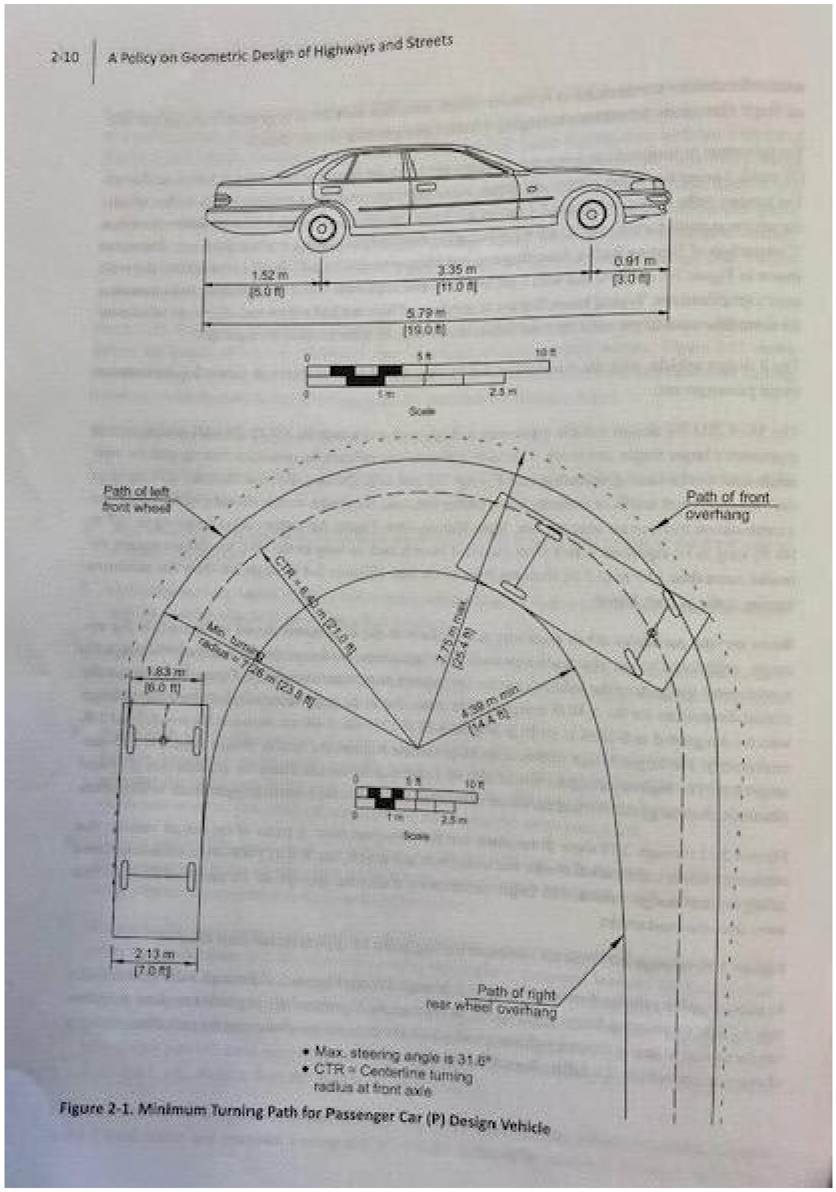
Speed Requirements:

TABLE I MINIMUM DESIGN SPEEDS FOR LOW-VOLUME ROADS				
TYPE OF TERRAIN	DESIGN SPEED (MPH) FOR SPECIFIED DESIGN ADT (VEH/DAY)			
	UNDER 50	50 TO 250	250 TO 400	400 TO 2,000
LEVEL	30	30	40	50
ROLLING	20 J	30	30	40
MOUNTAINOUS	20 J	20 J	20 J	30

Design Speed for under 50 veh/day on level terrain: 30 mph

<u>Roadway Standards for Design Vehicle</u>

Design Vehicle:	Passenger Car
Width of Passenger Car:	7 ft



Minimum Design Turning Radius for Passenger Car	23.8 ft
Minimum Inside Turning Radius for Passenger Car	14.4 ft

Maximum Grade for Local Rural Roads:

... occur together, ... passing opportunities. Where be provided so that the horizontal curves are visible to approaching drivers. greater-than-minimum sight distance should

Grades

Suggested maximum grades for local rural roads are shown in Table 5-2 as a function of type of terrain and design speed.

Table 5-2. Maximum Grades for Local Rural Roads

Type of Terrain	Metric: Maximum Grade (%) for Specified Design Speed (km/h)									U.S. Customary: Maximum Grade (%) for Specified Design Speed (mph)								
	20	30	40	50	60	70	80	90	100	15	20	25	30	40	45	50	55	60
Level	9	8	7	7	7	7	6	6	5	9	8	7	7	7	7	6	6	5
Rolling	12	11	11	10	10	9	8	7	6	12	11	11	10	10	9	8	7	6
Mountainous	17	16	15	14	13	12	10	10	—	17	16	15	14	13	12	10	10	—

Cross Slope

Traveled-way cross slope should be adequate to provide proper drainage. Normally, cross slopes range from 1.5 to 2 percent for paved surfaces and 2 to 6 percent for unpaved surfaces.

For unpaved surfaces, such as stabilized or loose gravel, and for stabilized earth surfaces, a 3 percent cross slope is desirable. For further information on pavement and shoulder cross slopes, see Sections 4.2.2 and 4.4.3.

Superelevation

... not more than 12 percent except where

Maximum Grade for Specified Design Speed 7%

Minimum Width of Traveled Way and Shoulder:

5-6 | A Policy on Geometric Design of Highways and Streets

Table 5-5. Minimum Width of Traveled Way and Shoulders

Metric					U.S. Customary				
Design Speed (km/h)	Minimum Width of Traveled Way (m) for Specified Design Volume (veh/day)				Design Speed (mph)	Minimum Width of Traveled Way (ft) for Specified Design Volume (veh/day)			
	under 400	400 to 1500	1500 to 2000	over 2000		under 400	400 to 1500	1500 to 2000	over 2000
20	5.4	6.0[a]	6.0	6.6	15	18	20[a]	20	22
30	5.4	6.0[a]	6.6	7.2[b]	20	18	20[a]	22	24[b]
40	5.4	6.0[a]	6.6	7.2[b]	25	18	20[a]	22	24[b]
50	5.4	6.0[a]	6.6	7.2[b]	30	18	20[a]	22	24[b]
60	5.4	6.0[a]	6.6	7.2[b]	40	18	20[a]	22	24[b]
70	6.0	6.6	6.6	7.2[b]	45	20	22	22	24[b]
80	6.0	6.6	6.6	7.2[b]	50	20	22	22	24[b]
90	6.6	6.6	7.2[b]	7.2[b]	55	22	22	24[b]	24[b]
100	6.6	6.6	7.2[b]	7.2[b]	60	22	22	24[b]	24[b]
					65	22	22	24[b]	24[b]
All speeds	Width of graded shoulder on each side of the road (m)				All speeds	Width of graded shoulder on each side of the road (ft)			
	0.6	1.5[a,c]	1.8	2.4		2	5[a,c]	6	8

[a] For roads in mountainous terrain with design volume of 400 to 600 veh/day, use 5.4-m [18-ft] traveled way width and 0.6-m [2-ft] shoulder width.

[b] Where the width of the traveled way is shown as 7.2 m [24 ft], the width may remain at 6.6 m [22 ft] on reconstructed highways where there is no crash pattern suggesting the need for widening.

[c] May be adjusted to achieve a minimum roadway width of 9 m [30 ft] for design speeds greater than 60 km/h [40 mph].

Minimum Width of Traveled Way for Design Speed and Volume	18 ft
Width of Graded Shoulder on Each Side of The Road	2 ft

Horizontal Curve Calculation

Horizontal Curves	
Side friction factor (based on superelevation)	$0.01e + f = \frac{V^2}{15R}$
Spiral Transition Length	$L_s = \frac{3.15V^3}{RC}$ $C =$ rate of increase of lateral acceleration [use 1 ft/sec^3 unless otherwise stated]
Sight Distance (to see around obstruction)	$\text{HSO} = R\left[1 - \cos\left(\frac{28.65S}{R}\right)\right]$ HSO = Horizontal sight line offset

Coefficient of Friction for Wet Asphalt (f)	.5-.8
Superelevation (e)	2.5%
Design Speed (V)	25 mph
Calculated Minimum Turning Radius (R)	62 ft

$$0.01e + f = V^2/15R$$

$$0.01(2.5\%) + .65 = (25)^2/(15R)$$

$$R = 62\ ft\ minimum$$

Signage Standards:

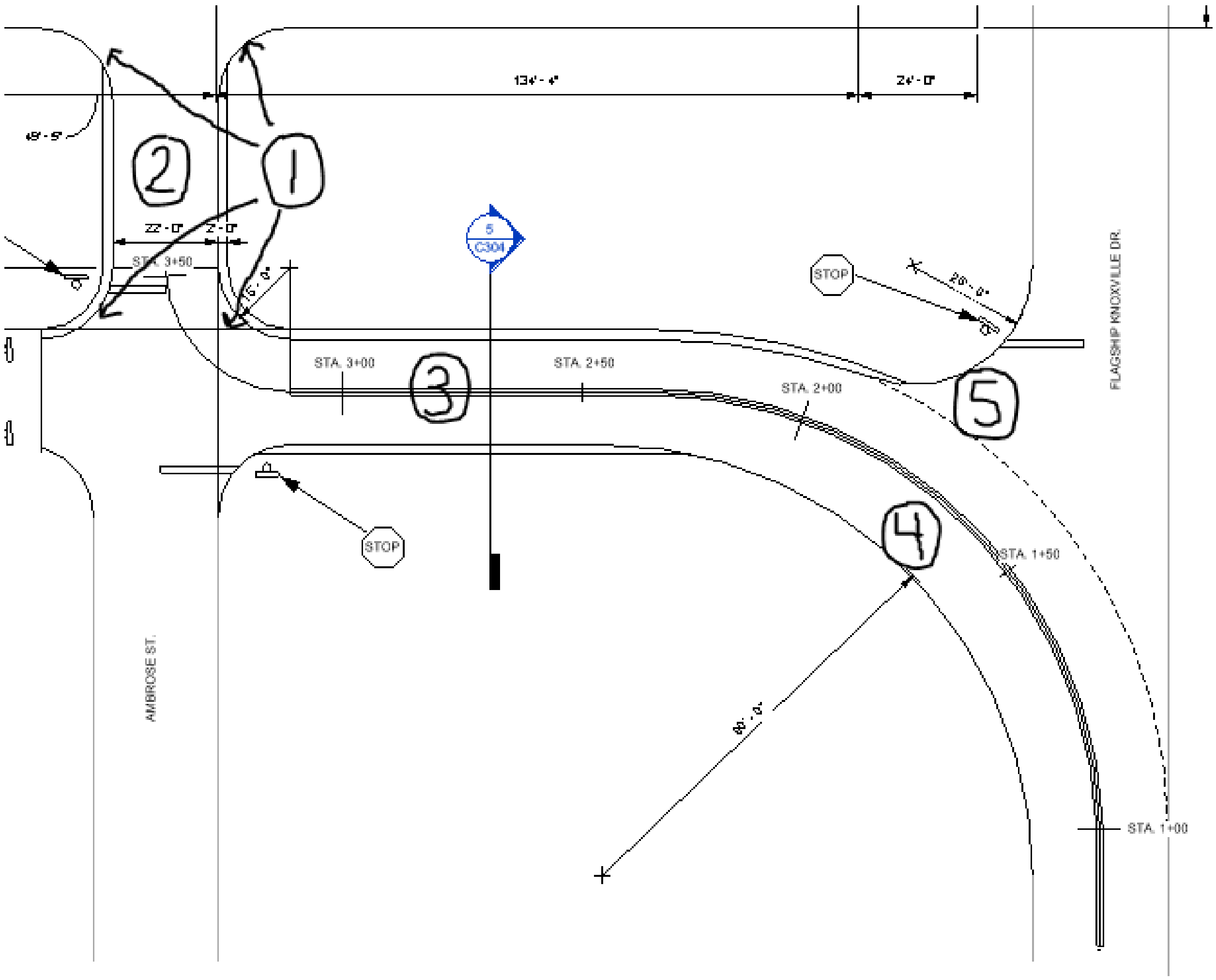
<u>Sign Sizes on Low-Volume Roads</u>

Table 5A-1. Sign and Plaque Sizes on Low-Volume Roads (Sheet 1 of 2)

Sign or Plaque	Sign Designation	Section	Sign Sizes		
			Typical	Minimum	Oversized
Stop	R1-1	5B.02	30 x 30	—	36 x 36
Yield	R1-2	5B.02	30 x 30 x 30	—	36 x 36 x 36
Speed Limit (English)	R2-1	5B.03	24 x 30	18 x 24	36 x 48
Do Not Pass	R4-1	5B.04	24 x 30	—	36 x 48
Pass With Care	R4-2	5B.04	24 x 30	18 x 24	36 x 48
Keep Right	R4-7	5B.04	24 x 30	18 x 24	36 x 48
Do Not Enter	R5-1	5B.04	30 x 30	—	36 x 36
No Trucks	R5-2	5B.04	24 x 24	—	30 x 30
One Way	R6-2	5B.04	18 x 24	—	24 x 30
No Parking (symbol)	R8-3	5B.05	24 x 24	18 x 18	30 x 30
No Parking	R8-3a	5B.05	18 x 24	—	24 x 30
No Parking (plaque)	R8-3cP,3dP	5B.05	24 x 18	18 x 12	30 x 24
Road Closed	R11-2	5B.04	48 x 30	—	—
Road Closed, Local Traffic Only	R11-3a	5B.04	60 x 30	—	—
Bridge Out, Local Traffic Only	R11-3b	5B.04	60 x 30	—	—
Road Closed to Thru Traffic	R11-4	5B.04	60 x 30	—	—
Weight Limit	R12-1	5B.04	24 x 30	—	36 x 48
Grade Crossing (Crossbuck)	R15-1	5F.02	48 x 9	—	—
Number of Tracks (plaque)	R15-2P	5F.02	27 x 18	—	—
Horizontal Alignment	W1-1,2,3,4,5	5C.02	30 x 30	—	36 x 36
One-Direction Large Arrow	W1-6	5C.02	36 x 18	—	48 x 24
Two-Direction Large Arrow	W1-7	5C.02	36 x 18	—	48 x 24
Chevron Alignment	W1-8	5C.02	12 x 18	—	18 x 24
Intersection Warning	W2-1,2,3,4,5,6	5C.03	30 x 30	—	36 x 36

Stop Sign Dimensions 30” x 30”

Roadway Volume Calculations



Section 1: 15' Radius Turn (x4)	193.16 ft^2
Section 2:	1,300 ft^2
Section 3:	3,042 ft^2
Section 4: Horizontal Curve	1,810 ft^2
Section 5: 25' Radius Turn	134 ft^2
Total Area of Asphalt	6,479 ft^2

Asphalt Depth: 4.5 in.

Total Volume of Asphalt: 2,430 ft^3

BDI has focused on jet blast solutions since the origin of jet aircraft in commercial and military aviation.

Taxi-Power Series

Utilized to protect ground support, roadways, parking areas, buildings and people from jet blast produced by aircraft using taxiways and aprons. These models are designed to withstand taxi and breakaway power from all types of aircraft.
Minimum distance required: 35 feet (10.67 meters) to the tail of the aircraft and 60 feet (18.29 meters) to the aircraft engine.
These models consist of both vertical and curved surfaces.

MODEL	HEIGHT	DEPTH	DESCRIPTION	AIRCRAFT
V-H	6' to 14' (1.8 to 4.3m)	9" (23cm)	I-Beam, cantilevered vertical blast fence with vertical struts, pier foundations & welded baseplates	Depends on height
V-HD	6' to 14' (1.8 to 4.3m)	11" (28cm)	Heavy duty cantilevered vertical blast fence with vertical struts, pier foundations & welded baseplates	Depends on height
V14LD	14' (4.3m)	12" (30cm)	I-Beam, cantilevered vertical blast fence with vertical struts, pier foundations & welded baseplates	Wide-body aircraft
LCV	14' to 32' (4.2 to 9.7m)	7.6" (19cm)	A-Frame with vertical blast fence surface for tight spaces with limited foundation	Depends on height
G6	6' (1.8m)	6' (1.8m)	Curved deflector designed for engines lower than 7 to 8 feet (2.1-2.4m)	General aviation (G.A.)
G10	10' (3.0m)	5' (1.5m)	Curved deflector designed for engines 7 to 8 feet (2.1-2.4m) above ground level	G.A. + some narrow body
G6M	6' (1.8m)	5' (1.5m)	Curved deflector designed for engines lower than 7 to 8 feet (2.1-2.4m)	General aviation
G14M-6	14' (4.3m)	9' (2.7m)	Curved deflector designed for engines 10 to 11 feet (3.0-3.3m) above ground level	Wide-body aircraft
G20M-6	20' (6.0m)	14' 6" (4.4m)	Curved deflector designed for engines greater than 11 feet (3.3m) above ground level	All aircraft including A380
G22M-6	22' (6.7m)	14' 6" (4.4m)	Curved deflector designed for engines greater than 11 feet (3.3m) above ground level	All aircraft including A380
G8HD	8' (2.4m)	6' (1.8m)	Curved deflector designed for engines 5 to 6 feet (1.5-1.8m) above ground level	G.A. + some narrow body
G10HD	10' (3.0m)	7' (2.1m)	Curved deflector with narrow base, designed for light-duty jet blast protection	All aircraft
G6R	6' (1.8m)	5' (1.5m)	Curved deflector designed for engines less than 5 to 6 feet (1.5-1.8m) above ground level	General aviation
G8R	8' (2.4m)	5' (1.5m)	Curved deflector designed for engines 5 to 6 feet (1.5-1.8m) above ground level	G.A. + some narrow body
G12NB	12' (3.6m)	5' 8" (1.7m)	Curved deflector with narrow base, designed for light-duty jet blast protection	Narrow-body aircraft
G14NB	14' (4.3m)	5' 8" (1.7m)	Curved deflector with narrow base, designed for light-duty jet blast protection	Wide-body aircraft
G15NB	15' (4.5m)	5' 8" (1.7m)	Curved deflector with narrow base, designed for light-duty jet blast protection	Wide-body aircraft
G22NB	22' (6.7m)	14' 6" (4.4m)	Curved deflector designed for engines greater than 11 feet (3.3m)	All aircraft including A380

Full-Power Series

Utilized to protect ground support, roadways, parking areas, buildings and people from jet blast produced by aircraft using taxiways and aprons.
These models are used in maintenance areas where full-power run-ups are regularly performed and can support jet thrust up to 115,000 pounds.
Minimum distance required: 35 feet (10.67 meters) to the tail of the aircraft and 60 feet (18.29 meters) to the aircraft engine.
These models have a curved surface and require special anchors.

MODEL	HEIGHT	DEPTH	DESCRIPTION	AIRCRAFT
G8HD	8' (2.4m)	6' (1.8m)	Full-power run-ups, typically at the end of a runway	G.A. + some narrow body
G10HD	10' (3.0m)	7' (2.1m)	Full-power run-ups, typically at the end of a runway	G.A. + some narrow body
G11-S	11' (3.4m)	7' (2m)	Full-power run-ups, typically in a maintenance facility	B-52, KC-135
G14M-3	14' (4.3m)	9' (2.7m)	Full-power run-ups, typically at the end of a runway	Narrow + wide-body aircraft
U19	19' (5.8m)	14' 6" (4.4m)	Full-power run-ups, typically at a maintenance facility	Wide-body aircraft
G20M	20' (6.0m)	14' 6" (4.4m)	Curved deflector designed for engines that are higher than 11 feet (3.3m)	Wide-body aircraft
G22M	22' (6.7m)	14' 6" (4.4m)	Curved deflector designed for engines that are higher than 11 feet (3.3m)	All aircraft including A380
U35	35' (10.7m)	14' 6" (4.4m)	Full-power run-ups, typically at a maintenance facility	MD-11, DC10

Afterburner Series

Utilized for starting tests and engine maintenance.
These models are designed to withstand full afterburner run-ups, and to withstand surface temperatures up to 750° F (399°C).
Minimum distance required: 75 feet (23 meters) to the jet nozzles.
These models have a curved surface and require special anchors.

MODEL	HEIGHT	DEPTH	DESCRIPTION	AIRCRAFT
GS-12	12' (3.6m)	11' 6" (3.5m)	Maintenance testing, full-power run-ups with afterburners	Military fighters
GS-16	16' (4.9m)	13' (3.9m)	Maintenance testing, full-power run-ups with afterburners	Military fighters
GS-20	20' (6.1m)	13' (3.9m)	Maintenance testing, full-power run-ups with afterburners	Military fighters & bombers

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Appendix B: Water Resources Design Calculations

Runoff Calculations:

Knox County Tennessee Stormwater Management Manual

Knox County

Table 3-1. Design Applications for Recommended Hydrologic Methods

Analysis or Design Application	Manual Section	Rational Method	USGS Equations	SCS Method	Clark Unit Hydrograph	Water Quality Volume	TVA Equations
Water Quality Volume (WQv)	2.2.3					✓	
Channel Protection Volume(CPv)	2.3			✓			
Overbank Flood Protection(Qp_2, Qp_{10},Qp_{25})	2.4.1			✓			
Extreme Flood Protection (Qp_{100})	2.4.2			✓			
Storage Facilities	3.2			✓			
Outlet Structures	3.3			✓			
Gutter Flow and Inlets	7.6	✓					
Storm Drain Pipes	7.2	✓	✓	✓			✓
Culverts	7.3	✓	✓	✓			✓
Small Ditches	7.4	✓	✓	✓			✓
Open Channels	7.4		✓	✓			✓
Energy Dissipation	7.5		✓	✓			✓
Flood Studies	8.4.3		✓	✓	✓		✓

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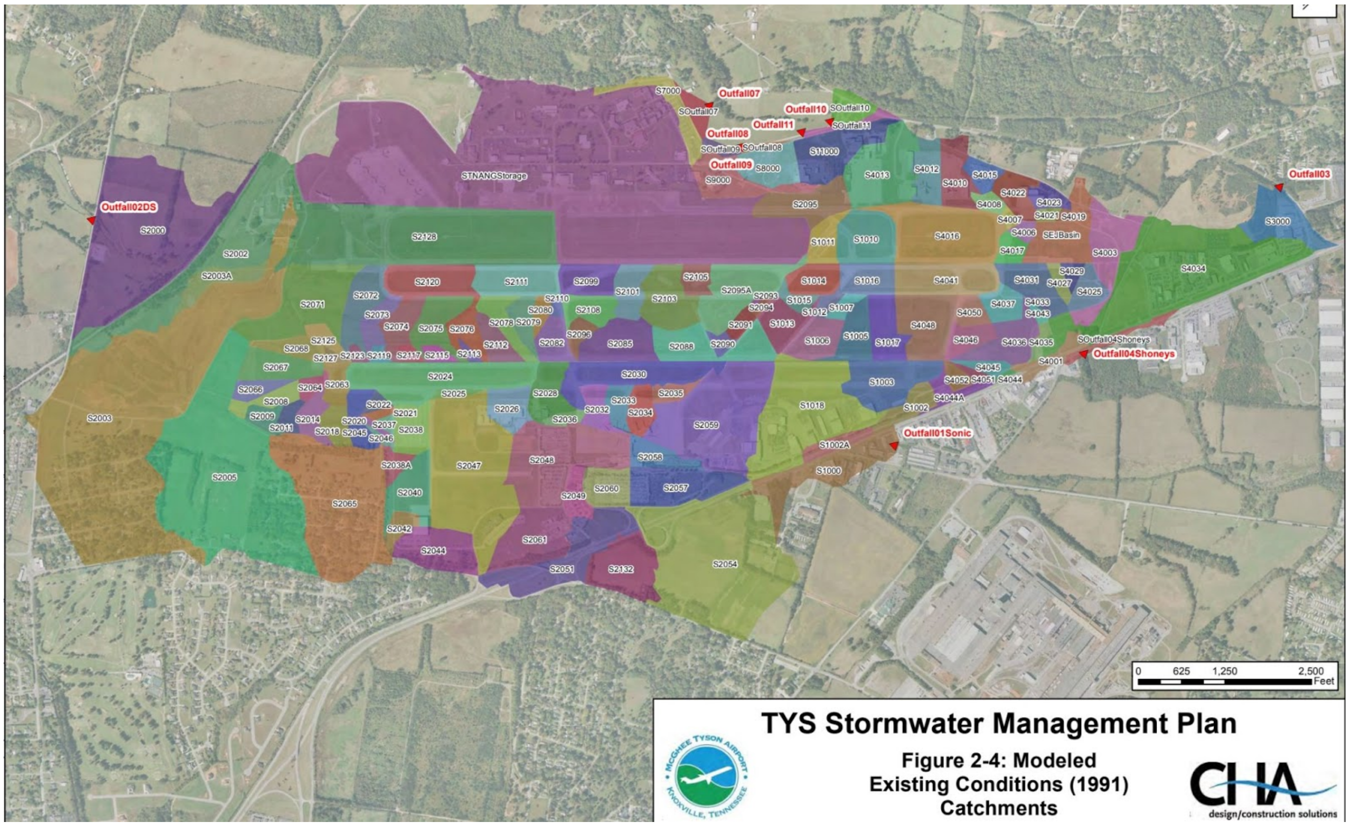
<u>Rational Method Variables:</u>

Ad- Watershed Area
Tc- Time of concentration
Iu- Rainfall Intensity
Cu-Undeveloped Runoff Coefficient
O- Undeveloped Runoff Rate
Cd- Developed runoff Coefficient

<u>Rational Method Equation:</u>

Equation 1-0: Flow Rate (Q) =Cd*Iu*Ad
Equation 1-1: Velocity (V)= Q/Ad

The Watershed area was calculated based on the catchments provided by CHA Consultants in the McGhee Tyson Airport Airfield Stormwater Management Manual. These areas provided a rough estimate of the watershed areas for each existing pipe in the south lateral ditch. From this, Google Earth was used to measure these areas. S2047 was used for the 108” RCP pipes. S2021, S2038, S2038A, S2040, S2042, and S 2044 were used for measuring the 84” RCP watershed. S2021, S2024, and S2025 were used for measuring the watershed areas for the 60” RCP.



Design Storm Rational

The design storm was chosen based on the guidance of the McGhee Tyson Airport Airfield Stormwater Management Manual in section 2.5.5.

Section 2 | McGhee Tyson Airport Existing Conditions

2.5.3 Hydrologic Characteristics

Each of the 147 catchments is defined by unique tributary area, total tributary area, hydraulic length, slope, percent imperviousness, and soil parameters that determine the response to precipitation events and the subsequent amount of stormwater runoff. Each of these parameters is calculated utilizing a combination of information from MKAA, the City of Alcoa, the Blount County GIS database, data from field surveying, site visits, and other published data. These parameters are summarized in **Appendix A.**

Tributary area, hydraulic length, slope, and percent imperviousness depend on the physical boundaries of the delineated catchment. Soil parameters are important for modeling infiltration. In place of expensive and time consuming detailed geotechnical documentation of soils for each catchment, the Natural Resources Conservation Service (NRCS) was consulted for predominant soils in the area. Stormwater management planning and drainage study experience were relied upon to select the appropriate soil infiltration parameters for each catchment. Based on geotechnical analysis previously conducted at TYS soils exhibit characteristics similar to NRCS Group "C," exhibiting moderately high runoff when thoroughly wet. The geotechnical analysis reports are included as **Appendix B** of this SWMP.

2.5.4 Hydraulic Representation of Airport

The storm water collection system is represented by nodes (e.g. junctions, manholes, catch basins) and links (e.g. conduits, channels, weirs). Modeled nodes were named according to the tributary drainage basin using a code developed specifically for this SWMP. The node naming nomenclature consists of a four or five digit ID where the numbers in the thousands represent the drainage basin and the numbers in the hundreds represent the node number (e.g. node 2038 is node number 38 in Drainage Basin 2 and node 11001 is node 1 in Drainage Basin 11). Modeled links were named with MKAA's nomenclature upstream node ID followed by an underscore ("_") then the downstream node ID (e.g. 2003_2002, flows from node 2003 to node 2002). The existing conditions model for the TYS SWMP contains 208 junction nodes, 2 storage units, 211 links, and nine outfalls.

2.5.5 Critical Precipitation Events

The TYS stormwater management system is designed to address stormwater quality and convey stormwater quantity. A stormwater quality management system at TYS will treat the runoff from all storm events of 1.1 inches or less, as well as the first 1.1 inches of runoff for all larger storm events. A stormwater quantity management system will be able to convey the peak flows and runoff volumes from the 2-year, 10-year, 25-year, and 100-year 24-hour NRCS Type II precipitation events to receiving streams at the pre-development peak flow rate. These design storms were chosen because the City of Alcoa Ordinance Number 08-154 (which mirrors Knox County Standards) requires the post-developed peak flow rate not exceed the pre-developed peak flow rate for each storm event. The critical precipitation events are summarized in **Table 2-2**. The critical precipitation events will be used to evaluate the system under existing conditions to establish stormwater discharge limits that must be met under future conditions.

Rational Method and Storage Steps:

As in the graphical approach, various storm durations, t_d, are selected and the largest value of $S(t_d)$ obtained is used to design the detention pond. Figure 6.2.2 is a worksheet which may be used for computations based on Equation 6.2.3.

The step by step procedure to compute the storage volume by using the rational method is as follows.

Step 1. Determine the area, A_U, runoff coefficient, C_U, and time of concentration for the undeveloped site. By using the appropriate intensity-duration-frequency curve determine the intensity, i_U, corresponding to the return period for the allowable outflow rate.

Step 2. Calculate the runoff (O(t)) from the undeveloped site. $O(t) = C_U i_U A_U$; or use the allowable release rate determined by other methods.

Step 3. Determine the developed runoff coefficient, C_D.

Step 4. Determine the rainfall intensities (i_d) for various durations (t_d), for the specified return period. Recommended durations are 10, 20, 30, 40, 50 min and 1, 1.5, 2, 3, 4, 5, 6, 7, 8, 9 and 10 hours.

Step 5. Determine the inflow rate to the detention pond. $I(t_d) = C_D i_d A_D$

Step 6. Compute the required storage for each duration,

$$S(t_d) = \frac{t_d}{12}[I(t_d) - O(t)] \qquad \text{(acre-ft)}$$

Step 7. Select the largest volume for designing the detention pond.

Various agencies have set guidelines for the selection of i_U, i_d, C_U and C_d. One agency, the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) (Metropolitan Sanitary District of Greater Chicago prior to 1989), uses the following criteria.

i_U based on a 3-year return period
i_D based on 100-year return period
$C_U \leq 0.15$
$C_D \geq 0.35$

In Example 6.2.1 these criteria are applied and the use of this procedure is demonstrated. A computer program which can be used to perform these computations is included at the end of the chapter. The calculations may also be performed conveniently using a spreadsheet.

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Example 6.2.1

A 10-acre parcel of land located in South Bend, Indiana which is currently a flat pasture with a clay and silt loam soil is to be developed to an area with the following characteristics: 20% parks, 50% single-family homes and 30% business. The overland travel path has a length of 150 feet and slope of 0.01 ft/ft. Determine the size of the detention pond required so that the 100-year runoff from the developed land will not exceed the 3-year runoff of the undeveloped land (MWRDGC guidelines). Use the rational method procedure outlined in Section 6.2.1.

Step 1: Undeveloped Runoff A = 10 acres

From Table 3.2.1, the runoff coefficient is 0.30. However, MWRDGC requires that the undeveloped runoff coefficient be less than or equal to 0.15. The overland flow time of concentration is computed by Kerby's Equation in Table 3.2.4.

$$t_c = 0.83\left[\frac{(150)(0.40)}{\sqrt{0.01}}\right]^{0.467} ; \quad t_c = 16.46 \textit{ minutes}$$

Step 2: The peak undeveloped flow is found by the rational method. Following the procedure outlined in Section 2.2.4, the intensity for a three-year return period and 16.46 minute duration for Evansville, Indiana is found as follows.

c = 1.7204 α = 0.1753 d= 0.485 β = 1.6806

$$i = \frac{c\,T_r^{\alpha}}{(t+d)^{\beta}} = \frac{1.7204\,(3\,)^{0.1753}}{\left(\frac{16.46}{60}+0.485\right)^{1.6806}} = 3.313 \textit{ inches/hour}$$

$$Q_U = (0.15)(3.31)(10) = 4.97 \text{ cfs}$$

Step 3: Compute the developed runoff coefficient. From Table 3.1, a composite runoff coefficient can be determined.

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	Acres	*Type of Cover*	*Runoff Coefficient*	C_nA_n
	2	Parks	0.17	0.34
	5	Single Family Homes	0.40	2.00
	3	Business	0.60	1.80
TOTAL	10			4.14

$$C_D = \frac{\Sigma C_n A_n}{A_T} = \frac{4.14}{10} = 0.41 > 0.35$$

Step 4: Determine rainfall intensities for a 100-year return period for duration of 10, 20, 30, 40 and 50 minutes and 1, 1.5, 2, 3, 4, 5, 6, 7, 8, 9 and 10 hours for Evansville, Indiana using the following equation (where t is in hours):

For t ≤ 1 hour:

$$i = \frac{c\,T_r^{\alpha}}{(t+d)^{\beta}} = \frac{1.7204\,(100\,)^{0.1753}}{(t+0.485\,)^{1.6806}}$$

For t >1 hour:

$$i = \frac{c\,T_r^{\alpha}}{(t+d)^{\beta}} = \frac{1.2799(100\,)^{0.1872}}{(t+0.258\,)^{0.8252}}$$

t (hours)	i (inches/hr)	t (hours)	i (inches/hr)
0.17	7.92	3.00	1.14
0.33	5.40	4.00	0.92
0.50	3.96	5.00	0.77
0.67	3.04	6.00	0.67
0.83	2.42	7.00	0.59
1.00	1.98	8.00	0.53
1.50	1.90	9.00	0.48
2.00	1.55	10.00	0.44

Step 5: Determine the inflow rate, $I(t_d)$, and required storage at each of the above durations (See Figure 6.2.3).

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Project: **Example 6.21** **Detention Facility Design Return Period:** **100** **years**

Designer: **TTB** **Release Rate Return Period:** **3** **years**

Watershed Area:	10 acres
Time of Concentration (undeveloped):	16.46 minutes
Rainfall Intensity (i_U):	3.31 inches/hr
Undeveloped Runoff Coefficent (C_U):	0.15
Undeveloped Runoff Rate ($O=C_U i_U A_U$):	4.97 cfs
Developed Runoff Coefficent (C_D)	0.41

Storm Duration t_d (hours)	Rainfall Intensity i_d (inches/hr)	Inflow Rate $C_D i_D A$ (cfs)	Outflow Rate O (cfs)	Storage Rate $I(t_d)$-O (cfs)	Required Storage (I(td)-O)(t_d/12) (acre-feet)
0.17	7.92	32.48	4.97	27.51	0.38
0.33	5.40	22.15	4.97	17.18	0.48
0.50	3.96	16.22	4.97	11.25	0.47
0.67	3.04	12.47	4.97	7.50	0.42
0.83	2.42	9.94	4.97	4.97	0.34
1	1.98	8.14	4.97	3.17	0.26
1.5	1.90	7.80	4.97	2.83	0.35
2	1.55	6.35	4.97	1.38	0.23
3	1.14	4.69	4.97	*	*
4	0.92	3.76	4.97	*	*
5	0.77	3.16	4.97	*	*
6	0.67	2.74	4.97	*	*
7	0.59	2.42	4.97	*	*
8	0.53	2.18	4.97	*	*
9	0.48	1.98	4.97	*	*
10	0.44	1.82	4.97	*	*

Peak Storage

* Since I(tD) - O< zero, there is no storage needed

Figure 6.2.3
Detention Storage Calculations for Example 6.2.1 Using the Rational Method

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Required Storage Equations:

Equation 2-0: Inflow Rate (I) - $(Cd * Id * Ad)$
Equation 2-1: Storage Rate (Itd) - $(I - O)$
Equation 2-2: Required Storage- $(I - O) * (Tu/12)$

60”- RCP Flow and Storage Calculations

			Storm Duration (hours)	Rainfall Intensity (in/hr)	Inflow rate (CFS)	outflow rate(Cfs)	Storage Rate (CFS)	Required Storage (Acre Feet)
Watershed Area	10.42	Acres	0.17	3.7	34.31306	18.79768	0	0
Time of concentration (undeveloped)	20	Minuets	0.33	2.82	26.152116	18.79768	0	0
Rainfall Intensity (I_U)	4.1	In/Hr	0.5	2.22	20.587836	18.79768	0	0
Undevelped Runoff Coefficent (Cu)	0.44		0.67	1.86	17.249268	18.79768	1.548412	0.086453003
Undevelped Runoff Rate (O)	18.79768	CFS	0.83	1.62	15.023556	18.79768	3.774124	0.261043577
Developed Runoff Coefficent (Cd)	0.89		1	1.45	13.44701	18.79768	5.35067	0.445889167
			1.5	1.06	9.830228	18.79768	8.967452	1.1209315
			2	0.86	7.975468	18.79768	10.822212	1.803702
			3	0.66	6.120708	18.79768	12.676972	3.169243
			6	0.41	3.802258	18.79768	14.995422	7.497711
			12	0.24	2.225712	18.79768	16.571968	16.571968
			24	0.14	1.298332	18.79768	17.499348	34.998696

84” RCP Peak Flow and Storage Calculations

			Storm Duration (hours)	Rainfall Intensity (in/hr)	Inflow rate (CFS)	outflow rate(Cfs)	Storage Rate (CFS)	Required Storage (Acre-Feet)
Watershed Area	28.02	Acres	0.17	3.7	53.91048	50.54808	-3.3624	-0.047634
Time of concentration (undeveloped)	20	Minuets	0.33	2.82	41.088528	50.54808	9.459552	0.26013768
Rainfall Intensity (IU)	4.1	In/Hr	0.5	2.22	32.346288	50.54808	18.201792	0.758408
Undevelped Runoff Coefficent (Cu)	0.44		0.67	1.86	27.100944	50.54808	23.447136	1.30913176
Undevelped Runoff Rate (O)	50.54808	CFS	0.83	1.62	23.604048	50.54808	26.944032	1.86362888
Developed Runoff Coefficent	0.52		1	1.45	21.12708	50.54808	29.421	2.45175
			1.5	1.06	15.444624	50.54808	35.103456	4.387932
			2	0.86	12.530544	50.54808	38.017536	6.336256
			3	0.66	9.616464	50.54808	40.931616	10.232904
			6	0.41	5.973864	50.54808	44.574216	22.287108
			12	0.24	3.496896	50.54808	47.051184	47.051184
			24	0.14	2.039856	50.54808	48.508224	97.016448

108” RCP Peak Flow and Storage Calculations

			Storm Duration (hours)	Rainfall Intensity (in/hr)	Inflow rate (CFS)	outflow rate(Cfs)	Storage Rate (CFS)	Required Storage (Acre-Feet)
Watershed Area	67.25	Areas	0.17	3.7	129.389	121.319	-8.07	-0.114325
Time of concentration (undeveloped)	20	Minuets	0.33	2.82	98.6154	121.319	22.7036	0.624349
Rainfall Intensity (IU)	4.1	In/Hr	0.5	2.22	77.6334	121.319	43.6856	1.820233333
Undevelped Runoff Coefficent (Cu)	0.44		0.67	1.86	65.0442	121.319	56.2748	3.142009667
Undevelped Runoff Rate (O)	121.319	CFS	0.83	1.62	56.6514	121.319	64.6676	4.472842333
Developed Runoff Coefficent	0.52		1	1.45	50.7065	121.319	70.6125	5.884375
			1.5	1.06	37.0682	121.319	84.2508	10.53135
			2	0.86	30.0742	121.319	91.2448	15.20746667
			3	0.66	23.0802	121.319	98.2388	24.5597
			6	0.41	14.3377	121.319	106.9813	53.49065
			12	0.24	8.3928	121.319	112.9262	112.9262
			24	0.14	4.8958	121.319	116.4232	232.8464

Pad Drainage Pipes Peak Flow and Storage Calculations:

			Storm Duration (hours)	Rainfall Intensity (in/hr)	Inflow rate (CFS)	outflow rate(Cfs)	Storage Rate (CFS)	Required Storage (Acre-Feet)
Watershed Area	7.42	Acres	0.17	3.7	25.53222	27.07558	1.54336	0.021864267
Time of concentration (undeveloped)	20	Minuets	0.33	2.82	19.459692	27.07558	7.615888	0.20943692
Rainfall Intensity (IU)	4.1	In/Hr	0.5	2.22	15.319332	27.07558	11.756248	0.489843667
Undevelped Runoff Coefficent (Cu)	0.89		0.67	1.86	12.835116	27.07558	14.240464	0.795092573
Undevelped Runoff Rate (O)	27.07558	CFS	0.83	1.62	11.178972	27.07558	15.896608	1.099515387
Developed Runoff Coefficent	0.93		1	1.45	10.00587	27.07558	17.06971	1.422475833
			1.5	1.06	7.314636	27.07558	19.760944	2.470118
			2	0.86	5.934516	27.07558	21.141064	3.523510667
			3	0.66	4.554396	27.07558	22.521184	5.630296
			6	0.41	2.829246	27.07558	24.246334	12.123167
			12	0.24	1.656144	27.07558	25.419436	25.419436
			24	0.14	0.966084	27.07558	26.109496	52.218992

Soil Type:

4.3.3 Hydrologic Characteristics

Each catchment is defined by a unique tributary area, total tributary area, hydraulic length, slope, percent imperviousness, and soil parameters that determine the response to precipitation events and the subsequent amount of stormwater runoff. Each of these parameters is calculated utilizing a combination of information from MKAA, the City of Alcoa, the Blount County GIS database, data from field surveying, site visits, and other published data. These parameters are summarized in **Appendix E**.

Tributary area, hydraulic length, slope, and percent imperviousness depend on the physical boundaries of the delineated catchment. Soil parameters are important for modeling infiltration. In place of expensive and time consuming detailed geotechnical analysis of soils for each catchment, the NRCS was consulted for predominant soils in the area. Stormwater management planning and drainage study experience were relied upon to select the appropriate soil infiltration parameters for each catchment. Based on geotechnical analysis previously conducted at TYS soils exhibit characteristics similar to NRCS Group "C," exhibiting moderately high runoff when thoroughly wet.

Runoff Coefficient Value:

Table 3-7. Recommended Runoff Coefficient Values for Rational Method

Land Use	Runoff Coefficient (C) by Hydrologic Soil Group and Ground Slope											
	A			B			C			D		
	<2%	2 - 6%	>6%	<2%	2 - 6%	>6%	<2%	2 - 6%	>6%	<2%	2 - 6%	>6%
Forest	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Meadow	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Pasture	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Farmland	0.14	0.18	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Res. 1 acre	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Res. 1/2 acre	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.46
Res. 1/3 acre	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
Res. 1/4 acre	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
Res. 1/8 acre	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
Industrial	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets: ROW	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Parking	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97
Disturbed Area	0.65	0.67	0.69	0.66	0.68	0.70	0.68	0.70	0.72	0.69	0.72	0.75

Storm Frequency:

Per chapter 3 of the Knox County Tennessee Stormwater Management Manual, the precipitation frequency was chosen for a 10 year 33 minuet storm.

Table 3-4. Intensity-Duration-Frequency Curve Data

(Sources: Hershfield, 1961; NOAA, 1977)

ARI[1] (years)		24-Hour Precipitation Frequency Estimates (inches/hour) by Return Periods					
Hours	**Minutes**	**2-year**	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**
0.083	5	4.60	5.55	6.25	7.30	7.90	8.60
0.170	10	3.70	4.60	5.25	6.20	6.80	7.49
0.250	15	3.19	3.98	4.60	5.45	6.00	6.60
0.330	20	2.82	3.50	4.10	4.90	5.45	6.02
0.420	25	2.48	3.12	3.70	4.45	4.95	5.50
0.500	30	2.22	2.80	3.34	4.03	4.53	5.03
0.580	35	2.02	2.55	3.06	3.67	4.14	4.62
0.670	40	1.86	2.35	2.82	3.38	3.80	4.24
0.750	45	1.73	2.18	2.62	3.14	3.53	3.93
0.830	50	1.62	2.04	2.46	2.94	3.30	3.67
0.920	55	1.53	1.92	2.32	2.77	3.10	3.45
1.000	60	1.45	1.82	2.20	2.62	2.93	3.26
1.500	90	1.06	1.36	1.64	1.95	2.18	2.45
2.000	120	0.86	1.09	1.31	1.55	1.71	1.95
3.000	180	0.66	0.80	0.97	1.13	1.23	1.38
6.000	360	0.41	0.50	0.58	0.66	0.75	0.83
12.000	720	0.24	0.30	0.34	0.39	0.43	0.48
24.000	1440	0.14	0.17	0.20	0.23	0.25	0.27

1 - ARI= Average Recurrence Interval

Minimum Slope and Velocity:

Per Chapter 7 of the Knox County Tennessee Stormwater Management Manual.

7.2.5 Minimum Grade

Knox County requires that storm drains be designed such that velocities of flow will not be less than 2.5 feet per second at design flow, with a minimum slope of 0.5%. For very flat flow lines, the general practice is to design components so that flow velocities will increase progressively throughout the length of the pipe system. Upper reaches of a storm drain system should have flatter slopes than slopes of lower reaches. Progressively increasing slopes keep solids moving toward the outlet and deter settling of particles due to steadily increasing flow streams.

The minimum slopes are calculated by the modified Manning's formula:

Equation 7-9

$$S = \frac{(nV)^2}{2.22R^{4/3}}$$

where:

S = the slope of the pipe, ft/ft
n = Manning's roughness coefficient
V = mean velocity of flow, ft/s
R = hydraulic radius, ft (area divided by wetted perimeter)

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Pipe Design Criteria:

Chapter 7 in the Knox County Tennessee Stormwater Management Manual provides the criteria for design shown below.

7.3.2.1 Frequency Flood

The 25-year frequency storm shall be routed through all culverts and the 100-year storm shall be used as a check, to verify structures (e.g., houses, commercial buildings) are not flooded or increased damage does not occur to the highway or adjacent property for this design event.

7.3.2.2 Velocity Limitations

Both minimum and maximum velocities shall be considered when designing a culvert. The maximum velocity shall be consistent with channel stability requirements at the culvert outlet. The maximum allowable velocity is 15 feet per second. Outlet protection shall be provided where discharge velocities will cause erosion problems. To ensure self-cleaning during partial depth flow, culverts shall have a minimum velocity of 2.5 feet per second at design flow or lower, with a minimum slope of 0.5%.

7.3.2.3 Buoyancy Protection

Buoyancy protection shall be provided for all flexible culverts. This can be provided through the use of headwalls, endwalls, slope paving or other means of anchoring.

7.3.2.4 Length and Slope

The culvert length and slope shall be chosen to approximate existing topography. To the degree practicable, the culvert invert should be aligned with the channel bottom and the skew angle of the stream, and the culvert entrance should match the geometry of the roadway embankment.

7.3.2.5 Debris Control

Debris control shall be performed in a manner consistent with *Hydraulic Engineering Circular No. 9* entitled Debris Control Structures (FHWA, 1971), which contains criteria pertaining to the design of debris control structures.

7.3.2.6 Headwater Limitations

Headwater is water above the culvert invert at the entrance end of the culvert. The allowable headwater elevation is that elevation above which damage may be caused to adjacent property and/or the roadway. The headwater elevation is determined from an evaluation of land use upstream of the culvert and the proposed or existing roadway elevation. It is this allowable headwater depth that is the primary basis for sizing a culvert.

The following criteria related to headwater should be considered when designing a culvert for the 25-year design storm event.

- The *allowable headwater* is the depth of water that can be ponded at the upstream end of the culvert during the 100 yr event with clogged conditions, which will be limited by one or more of the following constraints or conditions.
  (1) The allowable headwater must not damage upstream property.
  (2) The ponding depth is to be no greater than the low point in the road grade.
  (3) The ponding depth is to be no greater than the elevation where flow diverts around the culvert.
  (4) Headwater elevations shall be established to delineate potential flood zones.
- In general, the constraint that gives the lowest allowable headwater elevation (HW) establishes the criteria for the hydraulic calculations.
- For drainage facilities with cross-sectional area equal to or less than 30 ft^2, HW/D should be equal to or less than 1.5.

Pipe Sizing Equations:

Equation 7-4: Pipe Sizing $d = 1.56[nQ/KnS^{1/2}]^{3/8}$

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In terms of discharge, the above equation can be written as shown in Equation 7-2.

Equation 7-2 $$Q = \frac{1.49AR^{2/3}S^{1/2}}{n}$$

where:

Q = rate of flow, cfs
A = cross sectional area of flow, ft^2

For circular pipes flowing full, the Manning Formula can be written as shown in Equations 7-3 and 7-4.

Equation 7-3 $$V = \frac{0.590D^{2/3}S^{1/2}}{n}$$

Equation 7-4 $$Q = \frac{0.463D^{8/3}S^{1/2}}{n}$$

where:

D = diameter of pipe, ft

Equations 7-5 and 7-6 present the Manning's Equation reformulated to determine friction losses for storm drain pipes.

Equation 7-5 $$H_f = \frac{2.87n^2V^2L}{S^{4/3}}$$

Equation 7-6 $$H_f = \frac{29n^2V^2L}{R^{4/3}(2g)}$$

Manning's n Values:

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Table 7-3. Manning's "n" Values
(Source: USDOT, 1985)

Type of Conduit	Wall & Joint Description	Manning's "n"
Concrete Pipe	Good joints, smooth walls	0.012
	Good joints, rough walls	0.016
	Poor joints, rough walls	0.017
Concrete Box	Good joints, smooth finished walls	0.012
	Poor joints, rough, unfinished walls	0.018
Corrugated Metal Pipes and Boxes Annular Corregations	2-2/3- by ½-inch corrugations	0.024
	6- by 1-inch corrugations	0.025
	5- by 1-inch corrugations	0.026
	3- by 1-inch corrugations	0.028
	6-by 2-inch structural plate	0.035
	9-by 2-1/2 inch structural plate	0.035
Corrugated Metal Pipes, Helical Corrugations, Full Circular Flow	2-2/3-by ½-inch corrugated 24-inch plate width	0.012
Spiral Rib Metal Pipe	3/4 by 3/4 in recesses at 12 inch spacing, good joints	0.013
High Density Polyethylene (HDPE)	Corrugated Smooth Liner	0.015
	Corrugated	0.020
Polyvinyl Chloride (PVC)		0.011

Note: For further information concerning Manning "n" values for selected conduits consult Hydraulic Design of Highway Culverts, Federal Highway Administration, HDS No. 5, page 163

Proposed Extended Pipes Sizing and Velocity Sizing .

Pipe ID	pipe 43 (1)	pipe 43	pipe 36	pipe 45	pipe 44	pipe 35	pipe 42	pipe 40	Pipe 35
Flow (Q) CFS	69.33	69.33	121.319	121.319	121.319	121.319	50.54	18.7979	3.38375
Slope (S) %	17.63%	5.63%	0.12%	3.81%	4.48%	3.76%	5.08%	12.08%	0.57%
Mannings n	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.012
Required diameter	1.737735421	2.152462719	5.463077187	2.856672061	2.771208438	2.863756575	1.949055833	1.143441532	1.065634635
minmum	2	3	3	3	3	3	2	1.5	2
actual diameter	84	84	108	108	108	108	84	60	24
velocity	7.20967113	7.20967113	7.631925769	7.631925769	7.631925769	7.631925769	5.255686988	3.831419108	4.310509554

Proposed pad drainage pipe sizing and velocity calculations.

Pipe 48	pipe 48(1)	pipe 54	pipe 49	pipe 49 (1)	Pipe 53	pipe 50	pipe 50(1)	pipe 57	pipe 56	pipe 56(1)
3.38375	6.7675	6.7675	3.38375	3.38375	13.535	3.38375	3.38375	6.7675	3.38375	3.38375
0.53%	60.82%	64.15%	0.55%	0.54%	8%	0.59%	0.52%	8%	0.57%	0.53%
0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
1.080272044	0.575721447	0.569995907	1.072795291	1.076492561	1.092139179	1.058766303	1.084137173	0.842154432	1.065634635	1.080272044
2	1	1	2	2	2	2	2	1	2	2
24	24	24	24	24	24	24	24	24	24	24
4.310509554	8.621019108	8.621019108	4.310509554	4.310509554	17.24203822	4.310509554	4.310509554	8.621019108	4.310509554	4.310509554

Appendix C: Structural Design Calculations

GRAVITY LOADING:

Dead Loads

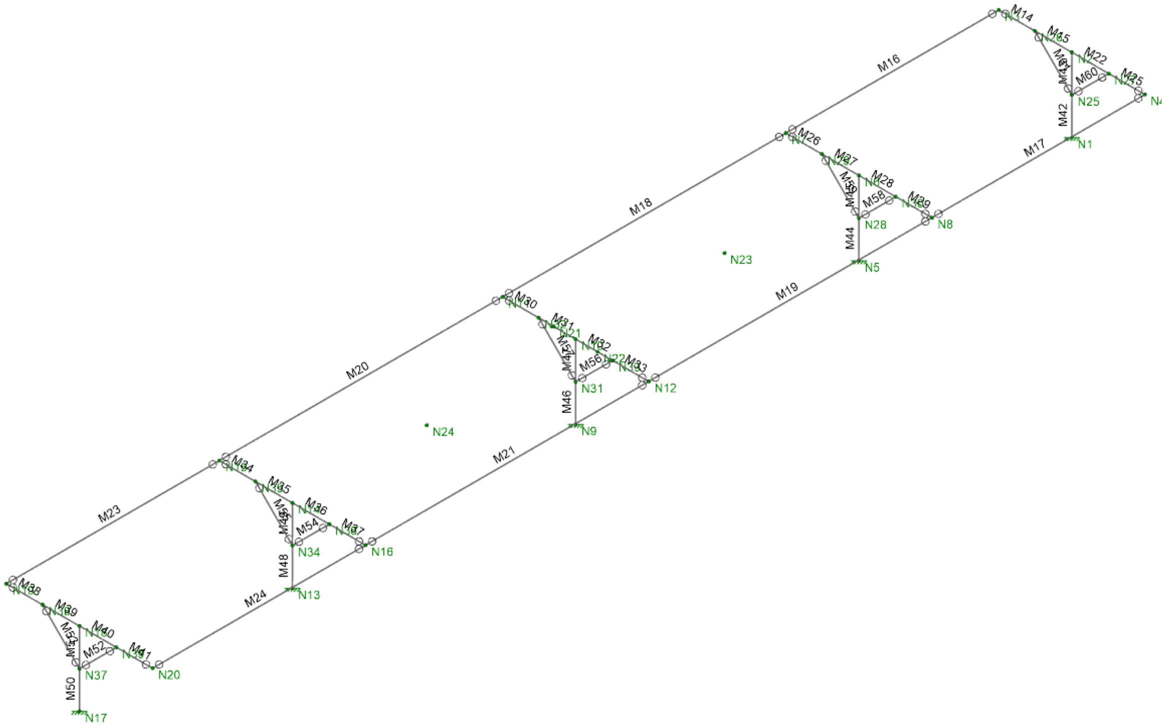
Dead loads shall consist of the weight of all materials of construction incorporated into the building including but not limited to walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding and other similarly incorporated architectural and structural items, and fixed service equipment including the weight of cranes. With not architectural drawings provided, a dead load of 20 psf is applied to all surfaces as an estimation

Live Loads

Minimum Uniformly Distributed Live Load	20 psf
Minimum Concentrated Live Load	2000 lb
Minimum Roof Live Load	20 psf

Parking Cover:

<u>RISA Model Member and Node Labels</u>



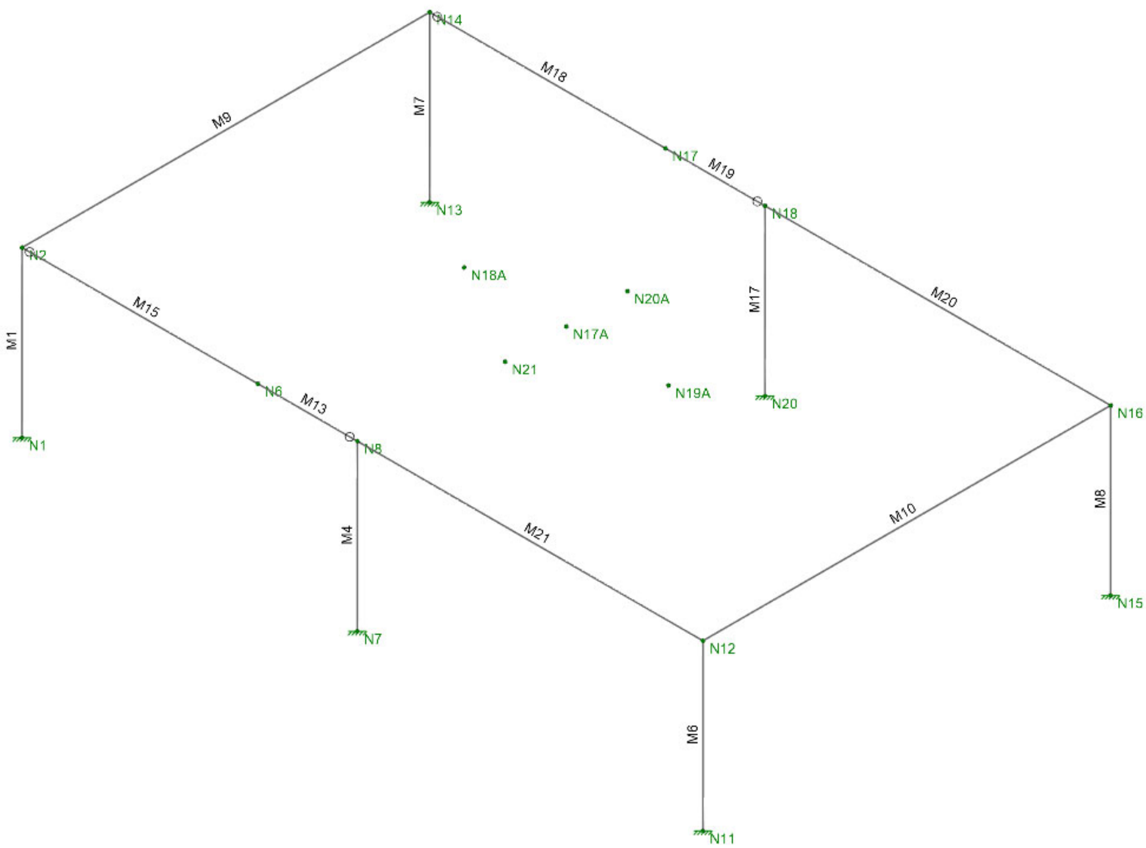
<u>Loading Calculation</u>

Tributary Width		9.9’
Applied Loads:	DL	20 psf
	RLL	20 psf
Distributed Loads:	DL	198 lb/ft
	RLL	198 lb/ft

For member results, see AC01-Parking Design RISA Output

Terminal:

RISA Model Member and Node Labels



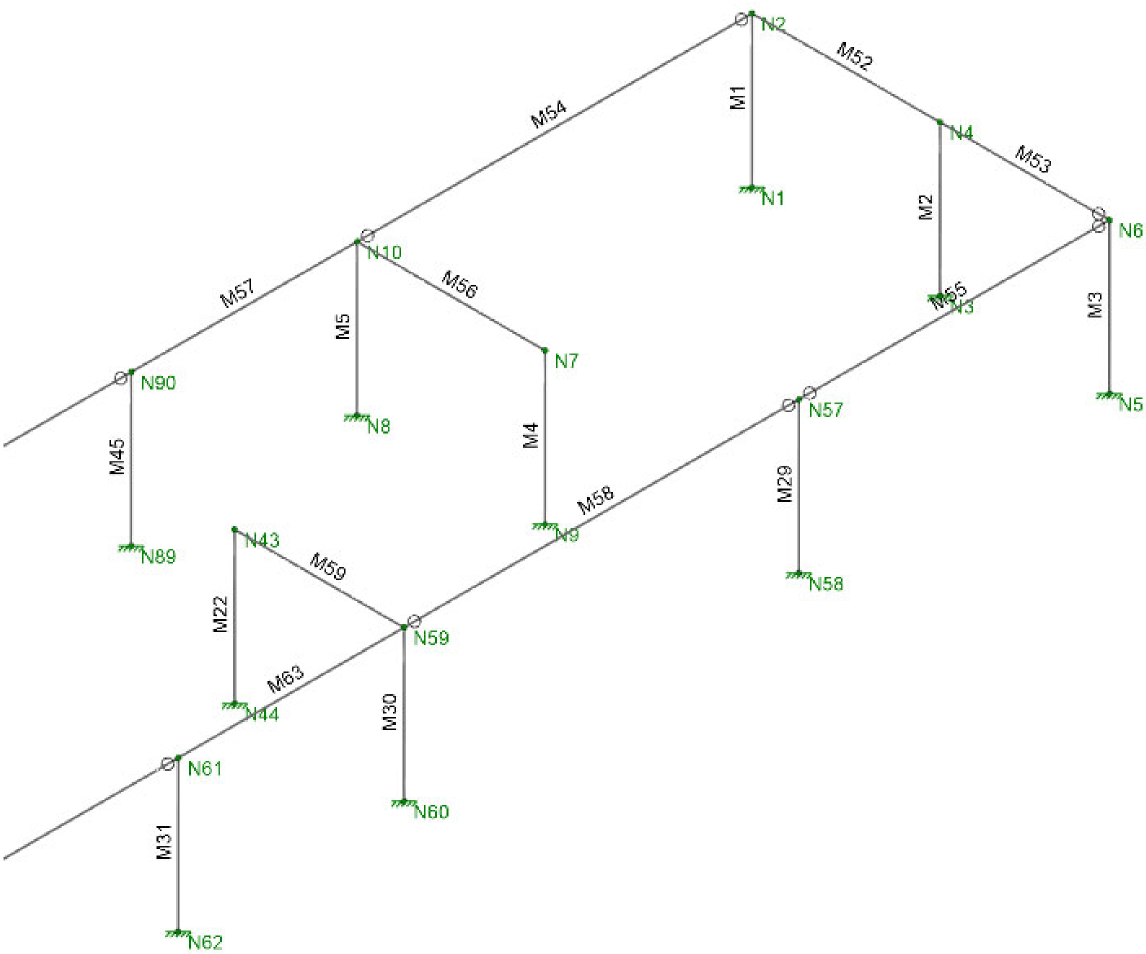
Loading Calculation

Tributary Width		14.9’
Applied Loads:	DL	20 psf
	RLL	20 psf
Distributed Loads:	DL	298 lb/ft
	RLL	298 lb/ft

For member results, see AC02-Terminal Design RISA Output

Hangar:

RISA Model Member and Node Labels



Loading Calculation

Tributary Width		19’
Applied Loads:	DL	20 psf
	RLL	20 psf
Distributed Loads:	DL	380 lb/ft
	RLL	380 lb/ft

For member results, see AC03-Hangar Design RISA Output

Repetitive Members have been eliminated from the output

SEISMIC LOADING

General Parameters

Importance Factor (I_e)	1.0
Site Class	D
Spectral Response Acceleration Parameters:	
S_s	0.893
S_1	0.16
S_{MS}	1.02
S_{M1}	0.365
S_{DS}	0.68
S_{D1}	0.243
Long Period Transition Period (T_L)	12
Short Period Site Coefficient (F_a)	1.143
Long Period Site Coefficient (F_v)	2.28

values from ATC have changed slightly as shown below

ATC Hazards by Location

Search Information

Address: tyson mcghee airport

Coordinates: 35.810833, -83.993889

Elevation: 962 ft

Timestamp: 2021-04-25T15:52:14.956Z

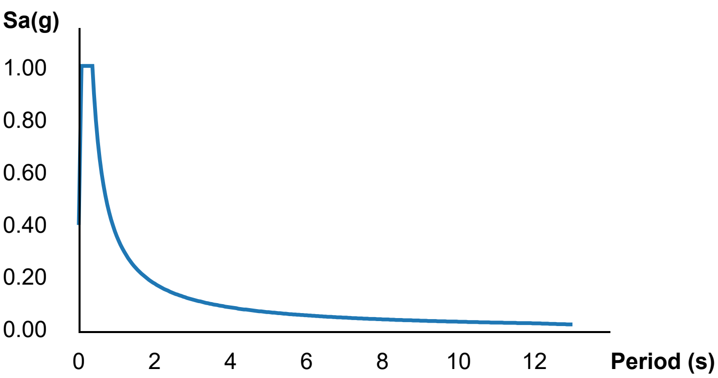
Hazard Type: Seismic

Reference Document: ASCE7-16

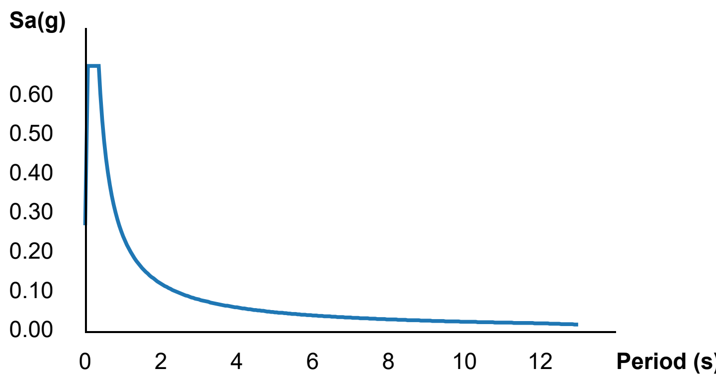
Risk Category: II

Site Class: D

MCER Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S_S	0.885	MCE_R ground motion (period=0.2s)
S_1	0.159	MCE_R ground motion (period=1.0s)
S_{MS}	1.014	Site-modified spectral acceleration value
S_{M1}	0.363	Site-modified spectral acceleration value
S_{DS}	0.676	Numeric seismic design value at 0.2s SA
S_{D1}	0.242	Numeric seismic design value at 1.0s SA

Additional Information

Name	Value	Description
SDC	D	Seismic design category
F_a	1.146	Site amplification factor at 0.2s
F_v	2.282	Site amplification factor at 1.0s

CR_S	0.875	Coefficient of risk (0.2s)
CR_1	0.934	Coefficient of risk (1.0s)
PGA	0.5	MCE_G peak ground acceleration
F_{PGA}	1.1	Site amplification factor at PGA
PGA_M	0.55	Site modified peak ground acceleration
T_L	12	Long-period transition period (s)
SsRT	0.885	Probabilistic risk-targeted ground motion (0.2s)
SsUH	1.012	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.159	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.17	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.5	Factored deterministic acceleration value (PGA)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

Hazard loads are provided by the U.S. Geological Survey Seismic Design Web Services.

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Terminal Calculations

Designed as a steel ordinary moment frame analyzed by the Equivalent Lateral Force Procedure.

Response Modification Coefficient (R[a])	3.5
Overstrength Factor (Ω_o)	3
Deflection Amplification Factor (C_d[b])	3
Redundancy Factor (ρ)	1.0
Average Roof Height (h)	12’
Building Period Coefficient (C_t)	0.028
Level Under Construction (x)	0.8
Seismic Response Coefficient (C_s):	
$C_s=(S_{DS})/(R/I_e)$	0.1943
Approximate Fundamental Period of the Building (T_a):	
$T_a=C_t h^x$	0.2044
Maximum Seismic Response Coefficient (C_s):	
$C_{s,max}=(S_{D1})/(T(R/I_e))$	0.3397
Seismic Weight (W)	18.766 k
Base Shear (V):	
$V=\rho C_S W$	3.65 k

Parking Calculations

Designed as a steel ordinary cantilever column analysed by the Equivalent Lateral Force Procedure.

Response Modification Coefficient (R[a])	1.25
Overstrength Factor (Ω_o)	1.25
Deflection Amplification Factor (C_d[b])	1.25
Redundancy Factor (ρ)	1.0
Average Roof Height (h)	10’
Building Period Coefficient (C_t)	0.02
Level Under Construction (x)	0.75
Seismic Response Coefficient (C_s):	
$C_s=(S_{DS})/(R/I_e)$	0.272
Approximate Fundamental Period of the Building (T_a):	

$T_a=C_t h^x$	0.1125
Maximum Seismic Response Coefficient (C_s):	
$C_{s,max}=(S_{D1})/(T(R/I_e))$	1.728
Seismic Weight (W)	76.428 k
Base Shear (V):	
$V=\rho C_S W$	20.79 k

Hangar Calculations

Designed as a steel ordinary moment frame analysed by the Equivalent Lateral Force Procedure.

Response Modification Coefficient (R^a)	3.5
Overstrength Factor (Ω_o)	3
Deflection Amplification Factor ($C_d{}^{\mathbf{b}}$)	3
Redundancy Factor (ρ)	1.0
Average Roof Height (h)	16'
Building Period Coefficient (C_t)	0.028
Level Under Construction (x)	0.8
Seismic Response Coefficient (C_s):	
$C_s=(S_{DS})/(R/I_e)$	0.1943
Approximate Fundamental Period of the Building (T_a):	
$T_a=C_t h^x$	0.2573
Maximum Seismic Response Coefficient (C_s):	
$C_{s,max}=(S_{D1})/(T(R/I_e))$	0.2698
Seismic Weight (W)	548.36 k
Base Shear (V):	
$V=\rho C_S W$	106.55 k

WIND LOADING:

General Parameters

Risk Category	II
Ultimate Wind Speed (26.5.1B)	105 mph

Terminal Calculations

Wind Directionality Factor (K_d)	0.85
Exposure Category	C
Topographic Factor (K_{zt}):	
K_1	0.28
K_2	1.00
K_3	1.00
$K_{zt} = (1+K_1K_2K_3)^2$	1.64
Ground Elevation Factor (K_e)	0.96
Gust Effect Factor (G)	0.85
Enclosure Classification	ENCLOSED
Internal Pressure Coefficient (GC_{pi})	±0.18
Velocity Pressure Exposure Coefficient (K_h/K_z)	0.57
Velocity Pressure (q):	
$q= 0.00256K_zK_{zt}K_dK_eV^2$	21.12 lb/ft^2
External Pressure Coefficient (C_p):	
Windward	0.8
Leeward	-0.5
Pressure:	
$P = qGC_p$	
Windward	14.4 lb/ft^2
Leeward	-9.0 lb/ft^2

<u>Parking Cover Calculations</u>

Wind Directionality Factor (K_d)	0.85
Exposure Category	B
Topographic Factor (K_{zt}):	
K_1	0.28
K_2	1.00
K_3	1.00
$K_{zt} = (1+K_1K_2K_3)^2$	1.64
Ground Elevation Factor (K_e)	0.96
Gust Effect Factor (G)	0.85
Enclosure Classification	OPEN
Internal Pressure Coefficient (GC_{pi})	0.00
Velocity Pressure Exposure Coefficient (K_h/K_z)	0.57
Velocity Pressure (q):	
$q= 0.00256K_zK_{zt}K_dK_eV^2$	21.12 lb/ft^2
External Pressure Coefficient (C_p):	

0 to h/2	-0.9
h/2 to h	-0.9
h to 2h	-0.5
>2h	-0.3
Pressure:	
$P = qGC_p$	
0 to h/2	-16.2 lb/ft^2
h/2 to h	-16.2 lb/ft^2
h to 2h	-8.98 lb/ft^2
>2h	-5.39 lb/ft^2

<u>Hangar Calculations</u>

Wind Directionality Factor (K_d)	0.85
Exposure Category	B
Topographic Factor (K_{zt}):	
K_1	0.28
K_2	0.86
K_3	1.00
$K_{zt} = (1+K_1K_2K_3)^2$	1.54
Ground Elevation Factor (K_e)	0.96
Gust Effect Factor (G)	0.85
Enclosure Classification	PARTIALLY ENCLOSED
Internal Pressure Coefficient (GC_{pi})	±0.55
Velocity Pressure Exposure Coefficient (K_h/K_z)	0.62
Velocity Pressure (q):	
$q= 0.00256K_zK_{zt}K_dK_eV^2$	21.57 lb/ft^2
External Pressure Coefficient (C_p):	
Windward	0.8
Leeward	-0.5
Sidewall	-0.7
Roof (entire)	-0.9
Pressure:	
$P = qGC_p$	
Windward	17.26 lb/ft^2
Leeward	-10.79 lb/ft^2
Sidewall	-15.10 lb/ft^2
Roof	-19.41 lb/ft^2
Internal	±11.86 lb/ft^2

Terminal Member Results and Connection Design

Nodal loads and displacements, distributed loads, material take off, member internal forces results, and connection design results are shown in the following documents.

ECONOMICAL JOIST GUIDE

Combined K, VS, LH & DLH Series Load Table

29' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
16K3	193	106	5.9
18K3	218	136	6.2
16K4	232	124	6.7
20K3	243	170	6.6
18K4	263	159	7.0
20K4	293	199	7.4
18K5	296	179	7.7
22K4	324	242	7.8
20K5	330	223	8.1
22K5	365	272	8.7
26K5	434	384	8.0
24K6	435	354	8.4
28K6	511	486	9.1
28K7	550	522	9.5
18LH5	581	345	14
20LH5	595	395	13
18LH6	648	377	15
24LH6	708	567	14
24LH7	778	623	15
20LH7	786	518	16
24LH8	830	662	16
24LH9	977	775	18
24LH10	1033	822	19
24LH11	1088	861	20

30' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
18K3	203	123	6.1
16K4	216	112	6.6
20K3	227	153	6.5
18K4	245	144	6.9
20K4	274	179	7.3
18K5	276	161	7.7
20K5	308	201	8.0
20K6	336	218	8.7
22K6	371	266	8.2
26K5	405	346	8.0
24K6	406	319	8.4
26K6	441	377	8.8
28K6	477	439	9.0
26K7	492	417	9.2
28K7	531	486	9.5
26K8	544	457	10
26K9	550	459	10
20LH5	571	366	13
18LH6	605	340	15
24LH6	684	529	14
24LH7	752	582	15
24LH8	802	618	16
24LH9	944	724	18
24LH10	998	768	19
24LH11	1052	804	21

31' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
16K4	203	101	6.6
20K3	212	138	6.6
18K4	229	130	6.9
20K4	256	162	7.4
18K5	258	146	7.7
22K4	283	198	7.8
20K5	289	182	8.1
24K4	310	237	8.4
20K6	314	198	8.8
22K5	319	222	8.7
22K6	347	241	8.3
26K5	379	314	8.1
24K6	380	289	8.6
22K7	387	267	8.8
28K6	446	397	9.0
22K9	465	316	10
28K8	550	480	10
24LH6	662	495	14

31' LENGTH (Cont.)

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
24LH7	727	545	15
24LH8	776	579	16
24LH9	913	677	19
24LH10	965	718	20
24LH11	1017	752	21

32' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
16K2	142	71	5.5
16K3	158	79	5.8
18K3	178	101	6.1
20K4	240	147	7.2
18K5	242	132	7.6
20K5	271	165	7.9
24K4	290	215	8.1
22K5	299	201	8.4
22K6	326	219	8.4
26K5	356	285	8.0
24K6	357	262	8.5
26K6	387	309	8.6
28K6	418	361	8.9
22K9	436	287	10
28K7	466	400	9.5
26K8	477	375	9.9
28K8	515	433	10
28K9	549	463	11
24LH6	641	465	14
24LH7	704	511	15
24LH8	752	543	16
24LH9	884	635	19
24LH10	935	674	20
24LH11	985	705	20

33' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
18K3	168	92	6.1
20K4	226	134	7.3
22K4	249	164	7.9
20K5	254	150	8.1
24K4	273	196	8.3
20K6	277	163	8.7
22K5	281	183	8.5
26K5	334	259	8.0
24K6	335	239	8.3
26K6	364	282	8.6
28K6	393	329	8.8
26K7	406	312	9.1
28K7	438	364	9.4
28K8	484	399	10
26K9	488	370	11
28K9	527	432	11
28K10	532	435	11
24LH6	621	437	15
24LH7	683	480	16
24LH8	729	510	16
24LH9	857	597	19
24LH10	906	633	20
24LH11	955	663	22

34' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
18K3	158	84	6.1
20K3	176	105	6.4
18K4	190	98	6.9
18K6	233	120	8.2
24K4	257	179	8.1
20K6	261	149	8.6
22K5	265	167	8.4
26K5	315	237	7.9
26K6	343	257	8.5
28K6	370	300	8.8
26K7	382	285	9.1
28K7	412	333	9.4

34' LENGTH (Cont.)

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
24K9	423	286	10
28K8	456	364	10
28K9	496	395	11
28K10	516	410	11
28LH6	552	443	13
28LH7	624	499	14
28LH8	668	533	15
24LH8	707	480	17
28LH9	823	656	17
24LH9	832	562	20
28LH10	900	714	19
28LH11	965	763	20
28LH12	1060	835	23
28LH13	1105	872	23

35' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
18K3	149	77	6.1
20K3	166	96	6.5
18K4	179	90	6.9
20K4	200	112	7.3
20K6	246	137	8.7
26K5	297	217	7.9
26K6	323	236	8.5
28K6	349	275	8.7
26K7	360	261	9.0
28K7	389	305	9.4
28K8	430	333	9.9
26K9	433	310	10
28K9	468	361	11
28K10	501	389	11
28LH6	537	417	13
28LH7	606	471	14
28LH8	649	503	15
24LH8	677	447	17
28LH9	799	618	18
28LH10	874	673	20
28LH11	938	719	21
28LH12	1030	787	23
28LH13	1073	822	24

36' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
18K3	141	70	6.1
20K3	157	88	6.4
18K4	169	82	6.9
20K4	189	103	7.2
18K5	191	92	7.5
24K6	281	183	8.3
22K7	286	169	8.7
24K7	313	203	8.8
28K6	330	252	8.8
26K7	340	240	9.1
24K8	346	222	9.5
28K7	367	280	9.4
26K8	376	263	9.8
30K7	395	323	9.6
28K9	442	332	11
28K10	487	366	12
28LH6	521	394	13
28LH7	589	445	14
28LH8	631	475	15
24LH8	649	416	17
28LH9	777	584	18
28LH10	850	636	19
28LH11	911	680	21
28LH12	1001	744	23
28LH13	1043	777	24

37' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
20K3	148	81	6.4
20K4	179	95	7.3

37' LENGTH (Cont.)

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
26K5	265	183	7.9
24K6	266	169	8.3
28K6	312	232	8.7
26K7	322	221	9.1
28K7	348	257	9.3
30K7	373	297	9.5
28K8	384	282	9.9
26K9	387	262	10
30K8	413	325	10
28K9	418	305	11
30K9	449	352	11
30K10	474	374	12
28LH6	507	373	13
24LH6	530	331	15
28LH7	573	421	15
24LH7	588	367	16
28LH8	614	449	16
24LH8	622	388	17
28LH9	755	553	18
28LH10	826	602	21
28LH11	886	643	21
28LH12	974	704	23
28LH13	1015	735	25

38' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
20K3	141	74	6.3
20K4	170	87	7.2
24K6	252	156	8.3
28K6	296	214	8.6
26K7	305	204	9.0
28K7	329	237	9.2
30K7	354	274	9.5
28K8	364	260	9.9
26K9	367	241	10
30K8	391	300	10
28K9	396	282	11
30K9	426	325	11
30K10	461	353	11
28LH6	494	354	13
24LH6	504	306	15
28LH7	558	399	15
24LH7	565	343	16
28LH8	597	426	16
28LH9	735	524	19
28LH10	804	570	20
28LH11	863	609	22
28LH12	948	667	23
28LH13	988	696	26

39' LENGTH

Joist Type	Allowable Loads (PLF) Total	Allowable Loads (PLF) Uniform	Joist Weight (lbs./ft.)
20K3	133	69	6.4
20K4	161	81	7.3
20K5	181	90	7.9
28K6	280	198	8.6
26K7	289	188	9.0
28K7	313	219	9.1
30K7	336	253	9.5
28K8	346	240	9.9
26K9	348	223	10
30K8	371	277	10
28K9	376	260	11
30K9	404	300	11
26K10	413	262	12
30K10	449	333	12
32LH7	486	388	13
32LH8	528	421	14
28LH7	543	379	15
32LH9	662	526	17
32LH10	732	581	18
32LH11	802	635	20
28LH11	841	578	22

Node Loads and Enforced Displacements (BLC 6 : Wind Load Z)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N17A	L	Z	7.292	Active

Node Loads and Enforced Displacements (BLC 7 : Wind Load X)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N17A	L	X	3.915	Active

Node Loads and Enforced Displacements (BLC 8 : Partial Z Wind Load 1)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N18A	L	Z	5.469	Active

Node Loads and Enforced Displacements (BLC 9 : Partial Z Wind Load 2)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N19A	L	Z	5.469	Active

Node Loads and Enforced Displacements (BLC 10 : Partial X Wind Load 1)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N20A	L	X	2.936	Active

Node Loads and Enforced Displacements (BLC 11 : Partial X Wind Load 2)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N21	L	X	2.936	Active

Node Loads and Enforced Displacements (BLC 12 : EQ X)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N17A	L	X	9.72	Active

Node Loads and Enforced Displacements (BLC 13 : EQ Z)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N17A	L	Z	9.72	Active

Member Distributed Loads (BLC 1 : DL)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1	M18	Y	-0.298	-0.298	0	%100	Active
2	M20	Y	-0.298	-0.298	0	%100	Active
3	M15	Y	-0.298	-0.298	0	%100	Active
4	M21	Y	-0.298	-0.298	0	%100	Active

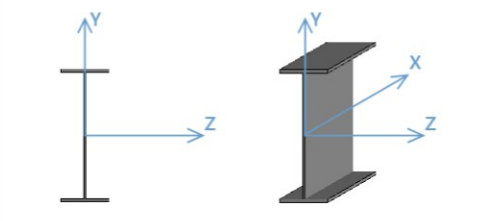
Member Distributed Loads (BLC 3 : RLL)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1	M18	Y	-0.298	-0.298	0	%100	Active
2	M20	Y	-0.298	-0.298	0	%100	Active
3	M15	Y	-0.298	-0.298	0	%100	Active
4	M21	Y	-0.298	-0.298	0	%100	Active

Material Take-Off

	Material	Size	Pieces	Length [ft]	Weight [k]
1	Hot Rolled Steel				
2	A500 Gr.B Rect	HSS8X8X3	6	72	1.415
3	A992	W12X45	2	48.9	2.179
4	A992	W14X22	2	59.4	1.312
5	A992	W14X43	2	50.4	2.16
6	Total HR Steel		12	230.7	7.066

Detail Report: M9 **Load Combination:** LC 1: Deflection 1



Input Data:

Shape:	W14X22	I Node:	N2
Member Type:	Beam	J Node:	N14
Length (ft):	29.71	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	100	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	13.7	Area (in^2):	6.49	S_w (in^4):	7
b_f (in):	5	Z_{yy} (in^3):	4.39	r_T (in):	1.23
t_f (in):	0.335	Z_{zz} (in^3):	33.2	J (in^4):	0.208
t_w (in):	0.23	C_w (in^6):	314	k_{det} (in):	1.063
I_{yy} (in^4):	7	W_{no} (in^2):	16.7	k_{des} (in):	0.735
I_{zz} (in^4):	199				

Design Properties:

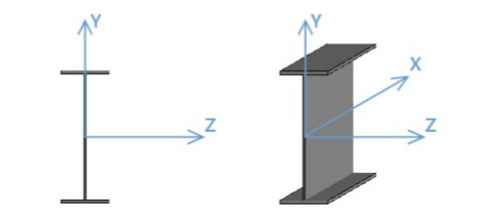
$L_{b\ y\text{-}y}$ (ft):	29.71	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/7823
$L_{b\ z\text{-}z}$ (ft):	29.71	$K_{z\text{-}z}$:	1	Max Defl Location:	15.005
$L_{comp\ top}$ (ft):	29.71	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	29.71	z sway:	No		
L_{torque} (ft):	29.71	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	194.311 k	-	-
Axial Compression Analysis	0.000 k	8.278 k	-	-
Flexural Analysis (Strong Axis)	1.51 k-ft	13.601 k-ft	-	-
Flexural Analysis (Weak Axis)	0.000 k-ft	10.953 k-ft	-	-
Shear Analysis (Major Axis y)	0.328 k	63.02 k	0.005	Pass
Shear Analysis (Minor Axis z)	0.000 k	60.18 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.111	Pass

Detail Report: M10

Load Combination: LC 1: Deflection 1



Input Data:

Shape:	W14X22	I Node:	N12
Member Type:	Beam	J Node:	N16
Length (ft):	29.71	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	100	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	13.7	Area (in^2):	6.49	S_w (in^4):	7
b_f (in):	5	Z_{yy} (in^3):	4.39	r_T (in):	1.23
t_f (in):	0.335	Z_{zz} (in^3):	33.2	J (in^4):	0.208
t_w (in):	0.23	C_w (in^6):	314	k_{det} (in):	1.063
I_{yy} (in^4):	7	W_{no} (in^2):	16.7	k_{des} (in):	0.735
I_{zz} (in^4):	199				

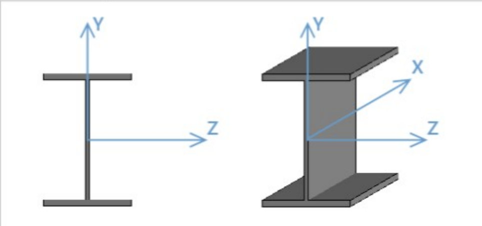
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	29.71	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/7822
$L_{b\ z\text{-}z}$ (ft):	29.71	$K_{z\text{-}z}$:	1	Max Defl Location:	14.705
$L_{comp\ top}$ (ft):	29.71	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	29.71	z sway:	No		
L_{torque} (ft):	29.71	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	194.311 k	-	-
Axial Compression Analysis	0.000 k	8.278 k	-	-
Flexural Analysis (Strong Axis)	1.51 k-ft	13.6 k-ft	-	-
Flexural Analysis (Weak Axis)	0.000 k-ft	10.953 k-ft	-	-
Shear Analysis (Major Axis y)	0.328 k	63.02 k	0.005	Pass
Shear Analysis (Minor Axis z)	0.000 k	60.18 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.111	Pass

Detail Report: M18 **Load Combination:** LC 1: Deflection 1



Input Data:

Shape:	W12X45	I Node:	N14
Member Type:	Beam	J Node:	N18
Length (ft):	24.438	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	100	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	12.1	Area (in^2):	13.1	S_w (in^4):	26.8
b_f (in):	8.05	Z_{yy} (in^3):	19	r_T (in):	2.15
t_f (in):	0.575	Z_{zz} (in^3):	64.2	J (in^4):	1.26
t_w (in):	0.335	C_w (in^6):	1650	k_{det} (in):	1.375
I_{yy} (in^4):	50	W_{no} (in^2):	23.2	k_{des} (in):	1.08
I_{zz} (in^4):	348				

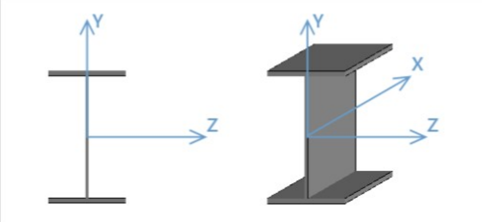
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	24.438	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/2115
$L_{b\ z\text{-}z}$ (ft):	24.438	$K_{z\text{-}z}$:	1	Max Defl Location:	10.368
$L_{comp\ top}$ (ft):	24.438	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	24.438	z sway:	No		
L_{torque} (ft):	24.438	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	392.216 k	-	-
Axial Compression Analysis	0.000 k	87.389 k	-	-
Flexural Analysis (Strong Axis)	25.983 k-ft	160.18 k-ft	-	-
Flexural Analysis (Weak Axis)	0.000 k-ft	47.405 k-ft	-	-
Shear Analysis (Major Axis y)	5.278 k	81.07 k	0.065	Pass
Shear Analysis (Minor Axis z)	0.065 k	166.302 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.162	Pass

Detail Report: M20 **Load Combination:** LC 1: Deflection 1



Input Data:

Shape:	W14X43	I Node:	N18
Member Type:	Beam	J Node:	N16
Length (ft):	25.192	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	100	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	13.7	Area (in^2):	12.6	S_w (in^4):	27.9
b_f (in):	8	Z_{yy} (in^3):	17.3	r_T (in):	2.14
t_f (in):	0.53	Z_{zz} (in^3):	69.6	J (in^4):	1.05
t_w (in):	0.305	C_w (in^6):	1950	k_{det} (in):	1.375
I_{yy} (in^4):	45.2	W_{no} (in^2):	26.3	k_{des} (in):	1.12
I_{zz} (in^4):	428				

Design Properties:

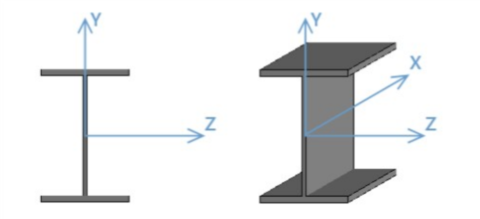
$L_{b\ y\text{-}y}$ (ft):	25.192	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/2233
$L_{b\ z\text{-}z}$ (ft):	25.192	$K_{z\text{-}z}$:	1	Max Defl Location:	14.504
$L_{comp\ top}$ (ft):	25.192	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	25.192	z sway:	No		
L_{torque} (ft):	25.192	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	377.246 k	-	-
Axial Compression Analysis	0.000 k	74.342 k	-	-
Flexural Analysis (Strong Axis)	26.107 k-ft	159.148 k-ft	-	-
Flexural Analysis (Weak Axis)	0.000 k-ft	43.164 k-ft	-	-
Shear Analysis (Major Axis y)	5.356 k	83.57 k	0.064	Pass
Shear Analysis (Minor Axis z)	0.053 k	152.335 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.164	Pass

Detail Report: M15

Load Combination: LC 1: Deflection 1



Input Data:

Shape:	W12X45	I Node:	N2
Member Type:	Beam	J Node:	N8
Length (ft):	24.438	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	100	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5\circ}F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	12.1	Area (in^2):	13.1	S_w (in^4):	26.8
b_f (in):	8.05	Z_{yy} (in^3):	19	r_T (in):	2.15
t_f (in):	0.575	Z_{zz} (in^3):	64.2	J (in^4):	1.26
t_w (in):	0.335	C_w (in^6):	1650	k_{det} (in):	1.375
I_{yy} (in^4):	50	W_{no} (in^2):	23.2	k_{des} (in):	1.08
I_{zz} (in^4):	348				

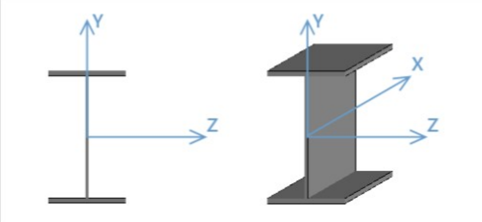
Design Properties:

$L_{b\ y\text{-}y}$ (ft) :	24.438	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/2115
$L_{b\ z\text{-}z}$ (ft) :	24.438	$K_{z\text{-}z}$:	1	Max Defl Location:	10.368
$L_{comp\ top}$ (ft) :	24.438	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft) :	24.438	z sway:	No		
L_{torque} (ft) :	24.438	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	392.216 k	-	-
Axial Compression Analysis	0.000 k	87.389 k	-	-
Flexural Analysis (Strong Axis)	25.983 k-ft	160.18 k-ft	-	-
Flexural Analysis (Weak Axis)	0.000 k-ft	47.405 k-ft	-	-
Shear Analysis (Major Axis y)	5.278 k	81.07 k	0.065	Pass
Shear Analysis (Minor Axis z)	0.065 k	166.302 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.162	Pass

Detail Report: M21 **Load Combination:** LC 1: Deflection 1



Input Data:

Shape:	W14X43	I Node:	N8
Member Type:	Beam	J Node:	N12
Length (ft):	25.192	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	100	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}°F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	13.7	Area (in^2):	12.6	S_w (in^4):	27.9
b_f (in):	8	Z_{yy} (in^3):	17.3	r_T (in):	2.14
t_f (in):	0.53	Z_{zz} (in^3):	69.6	J (in^4):	1.05
t_w (in):	0.305	C_w (in^6):	1950	k_{det} (in):	1.375
I_{yy} (in^4):	45.2	W_{no} (in^2):	26.3	k_{des} (in):	1.12
I_{zz} (in^4):	428				

Design Properties:

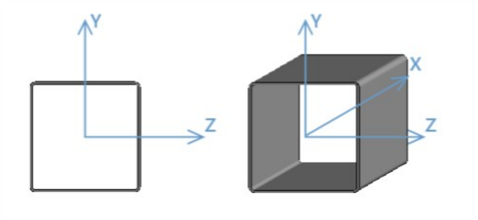
$L_{b\ y\text{-}y}$ (ft):	25.192	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/2233
$L_{b\ z\text{-}z}$ (ft):	25.192	$K_{z\text{-}z}$:	1	Max Defl Location:	14.504
$L_{comp\ top}$ (ft):	25.192	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	25.192	z sway:	No		
L_{torque} (ft):	25.192	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	377.246 k	-	-
Axial Compression Analysis	0.000 k	74.342 k	-	-
Flexural Analysis (Strong Axis)	26.107 k-ft	159.148 k-ft	-	-
Flexural Analysis (Weak Axis)	0.000 k-ft	43.164 k-ft	-	-
Shear Analysis (Major Axis y)	5.356 k	83.57 k	0.064	Pass
Shear Analysis (Minor Axis z)	0.053 k	152.335 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.164	Pass

Detail Report: M1

Load Combination: LC 1: Deflection 1



Input Data:

Shape:	HSS8X8X3	**I Node:**	N1
Member Type:	Column	**J Node:**	N2
Length (ft):	12	**I Release:**	Fixed
Material Type:	Hot Rolled Steel	**J Release:**	Fixed
Design Rule:	Typical	**I Offset (in):**	N/A
Number of Internal Sections:	100	**J Offset (in):**	N/A

Material Properties:

Material:	A500 Gr.B Rect	**Therm. Coeff. ($1e^{5}$°F^{-1}):**	0.65	**R_y:**	1.4
E (ksi):	29000	**Density (k/ft^3):**	0.527	**F_u (ksi):**	58
G (ksi):	11154	**F_y (ksi):**	46	**R_t:**	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	**I_{yy} (in^4):**	54.4	**Area (in^2):**	5.37
b_f (in):	8	**I_{zz} (in^4):**	54.4	**J (in^4):**	84.5
t (in):	0.174				

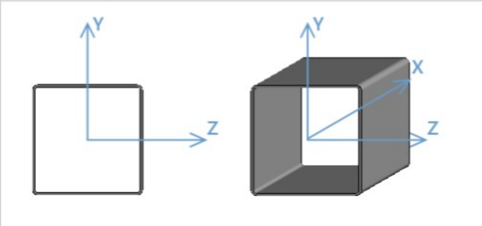
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	12	**$K_{y\text{-}y}$:**	1	**Max Defl Ratio:**	L/10000
$L_{b\ z\text{-}z}$ (ft):	12	**$K_{z\text{-}z}$:**	1	**Max Defl Location:**	0
$L_{comp\ top}$ (ft):	12	**y sway:**	No	**Span:**	N/A
$L_{comp\ bot}$ (ft):	12	**z sway:**	No		
L_{torque} (ft):	12	**Function:**	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	147.916 k	-	-
Axial Compression Analysis	3.451 k	118.601 k	-	-
Flexural Analysis (Strong Axis)	0.000 k-ft	28.863 k-ft	-	-
Flexural Analysis (Weak Axis)	0.926 k-ft	28.863 k-ft	-	-
Shear Analysis (Major Axis y)	0.006 k	43.009 k	0.000	Pass
Shear Analysis (Minor Axis z)	0.115 k	43.009 k	0.003	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.047	Pass
Torsional Analysis	-	29.326 k-ft	-	-

Detail Report: M4 **Load Combination:** LC 1: Deflection 1



Input Data:

Shape:	HSS8X8X3	**I Node:**	N7
Member Type:	Column	**J Node:**	N8
Length (ft):	12	**I Release:**	Fixed
Material Type:	Hot Rolled Steel	**J Release:**	Fixed
Design Rule:	Typical	**I Offset (in):**	N/A
Number of Internal Sections:	100	**J Offset (in):**	N/A

Material Properties:

Material:	A500 Gr.B Rect	**Therm. Coeff. ($1e^{5}$°F^{-1}):**	0.65	**R_y:**	1.4
E (ksi):	29000	**Density (k/ft^3):**	0.527	**F_u (ksi):**	58
G (ksi):	11154	**F_y (ksi):**	46	**R_t:**	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	**I_{yy} (in^4):**	54.4	**Area (in^2):**	5.37
b_f (in):	8	**I_{zz} (in^4):**	54.4	**J (in^4):**	84.5
t (in):	0.174				

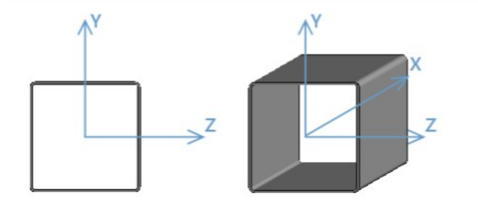
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	12	**$K_{y\text{-}y}$:**	1	**Max Defl Ratio:**	L/10000
$L_{b\ z\text{-}z}$ (ft):	12	**$K_{z\text{-}z}$:**	1	**Max Defl Location:**	0
$L_{comp\ top}$ (ft):	12	**y sway:**	No	**Span:**	N/A
$L_{comp\ bot}$ (ft):	12	**z sway:**	No		
L_{torque} (ft):	12	**Function:**	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	147.916 k	-	-
Axial Compression Analysis	10.815 k	118.601 k	-	-
Flexural Analysis (Strong Axis)	0.000 k-ft	28.863 k-ft	-	-
Flexural Analysis (Weak Axis)	0.000 k-ft	28.863 k-ft	-	-
Shear Analysis (Major Axis y)	0.01 k	43.009 k	0.000	Pass
Shear Analysis (Minor Axis z)	0.000 k	43.009 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.091	Pass
Torsional Analysis	-	29.326 k-ft	-	-

Detail Report: M6 **Load Combination:** LC 1: Deflection 1



Input Data:

Shape:	HSS8X8X3	I Node:	N11
Member Type:	Column	J Node:	N12
Length (ft):	12	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	100	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	I_{yy} (in^4):	54.4	Area (in^2):	5.37
b_f (in):	8	I_{zz} (in^4):	54.4	J (in^4):	84.5
t (in):	0.174				

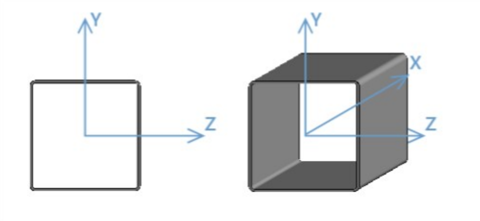
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	12	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/10000
$L_{b\ z\text{-}z}$ (ft):	12	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	12	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	12	z sway:	No		
L_{torque} (ft):	12	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	147.916 k	-	-
Axial Compression Analysis	3.585 k	118.601 k	-	-
Flexural Analysis (Strong Axis)	0.000 k-ft	28.863 k-ft	-	-
Flexural Analysis (Weak Axis)	0.926 k-ft	28.863 k-ft	-	-
Shear Analysis (Major Axis y)	0.006 k	43.009 k	0.000	Pass
Shear Analysis (Minor Axis z)	0.115 k	43.009 k	0.003	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.047	Pass
Torsional Analysis	-	29.326 k-ft	-	-

Detail Report: M7 **Load Combination:** LC 1: Deflection 1



Input Data:

Shape:	HSS8X8X3	**I Node:**	N13
Member Type:	Column	**J Node:**	N14
Length (ft):	12	**I Release:**	Fixed
Material Type:	Hot Rolled Steel	**J Release:**	Fixed
Design Rule:	Typical	**I Offset (in):**	N/A
Number of Internal Sections:	100	**J Offset (in):**	N/A

Material Properties:

Material:	A500 Gr.B Rect	**Therm. Coeff. ($1e^{5}$°F^{-1}):**	0.65	**R_y:**	1.4
E (ksi):	29000	**Density (k/ft^3):**	0.527	**F_u (ksi):**	58
G (ksi):	11154	**F_y (ksi):**	46	**R_t:**	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	**I_{yy} (in^4):**	54.4	**Area (in^2):**	5.37
b_f (in):	8	**I_{zz} (in^4):**	54.4	**J (in^4):**	84.5
t (in):	0.174				

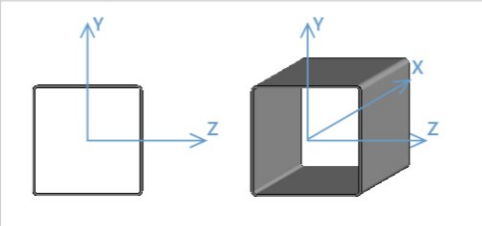
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	12	**$K_{y\text{-}y}$:**	1	**Max Defl Ratio:**	L/10000
$L_{b\ z\text{-}z}$ (ft):	12	**$K_{z\text{-}z}$:**	1	**Max Defl Location:**	0
$L_{comp\ top}$ (ft):	12	**y sway:**	No	**Span:**	N/A
$L_{comp\ bot}$ (ft):	12	**z sway:**	No		
L_{torque} (ft):	12	**Function:**	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	147.916 k	-	-
Axial Compression Analysis	3.451 k	118.601 k	-	-
Flexural Analysis (Strong Axis)	0.000 k-ft	28.863 k-ft	-	-
Flexural Analysis (Weak Axis)	0.926 k-ft	28.863 k-ft	-	-
Shear Analysis (Major Axis y)	0.006 k	43.009 k	0.000	Pass
Shear Analysis (Minor Axis z)	0.115 k	43.009 k	0.003	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.047	Pass
Torsional Analysis	-	29.326 k-ft	-	-

Detail Report: M8 **Load Combination:** LC 1: Deflection 1



Input Data:

Shape:	HSS8X8X3	I Node:	N15
Member Type:	Column	J Node:	N16
Length (ft):	12	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	100	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	I_{yy} (in^4):	54.4	Area (in^2):	5.37
b_f (in):	8	I_{zz} (in^4):	54.4	J (in^4):	84.5
t (in):	0.174				

Design Properties:

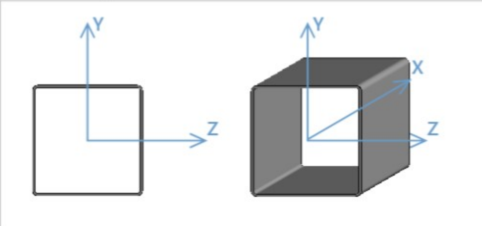
$L_{b\ y\text{-}y}$ (ft):	12	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/10000
$L_{b\ z\text{-}z}$ (ft):	12	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	12	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	12	z sway:	No		
L_{torque} (ft):	12	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	147.916 k	-	-
Axial Compression Analysis	3.585 k	118.601 k	-	-
Flexural Analysis (Strong Axis)	0.000 k-ft	28.863 k-ft	-	-
Flexural Analysis (Weak Axis)	0.926 k-ft	28.863 k-ft	-	-
Shear Analysis (Major Axis y)	0.006 k	43.009 k	0.000	Pass
Shear Analysis (Minor Axis z)	0.115 k	43.009 k	0.003	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.047	Pass
Torsional Analysis	-	29.326 k-ft	-	-

Detail Report: M17

Load Combination: LC 1: Deflection 1



Input Data:

Shape:	HSS8X8X3	I Node:	N20
Member Type:	Column	J Node:	N18
Length (ft):	12	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	100	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	I_{yy} (in^4):	54.4	Area (in^2):	5.37
b_f (in):	8	I_{zz} (in^4):	54.4	J (in^4):	84.5
t (in):	0.174				

Design Properties:

$L_{b\ y\text{-}y}$ (ft):	12	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/10000
$L_{b\ z\text{-}z}$ (ft):	12	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	12	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	12	z sway:	No		
L_{torque} (ft):	12	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): ASD Code Check

Limit State	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial				
Applied Loading - Shear	-	-	-	-
Axial Tension Analysis	0.000 k	147.916 k	-	-
Axial Compression Analysis	10.815 k	118.601 k	-	-
Flexural Analysis (Strong Axis)	0.000 k-ft	28.863 k-ft	-	-
Flexural Analysis (Weak Axis)	0.000 k-ft	28.863 k-ft	-	-
Shear Analysis (Major Axis y)	0.01 k	43.009 k	0.000	Pass
Shear Analysis (Minor Axis z)	0.000 k	43.009 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	-	-	0.091	Pass
Torsional Analysis	-	29.326 k-ft	-	-

Current Date: 4/20/2021 12:13 PM
Units system: English
File name: E:\Terminal Conncetions.rcnx

Steel connections

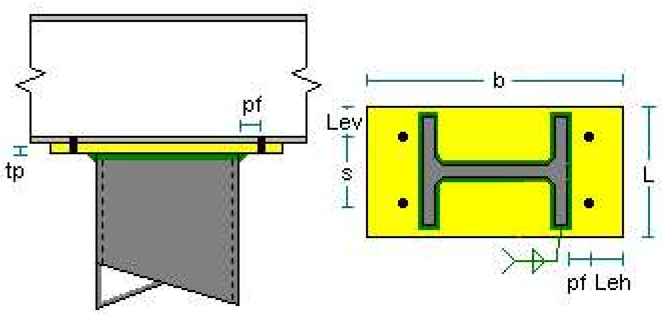
Detailed report

Connection name : CP_1PL_2B1
Connection ID : 3

Family: Column cap (CC)
Type: Cap Plate

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 14X34
Beam material	:	A992 Gr50
Built-up	:	No

Column

General

Support section	:	HSS_SQR 7X7X1_4
Support material	:	A500 GrB rectangular
Column orientation	:	Longitudinal

CAP PLATE

Connector

tp: Plate thickness	:	1 in
Plate material	:	A36
Bolts	:	1" A325 N
Lev: Transverse distance to edge	:	1.75 in
Leh: Longitudinal distance to edge	:	1.75 in
pf: distance bolt centerline-tension flange	:	1.75 in
s: Transverse bolt spacing	:	4.25 in
Hole type on plate	:	Standard (STD)

Beam side

Hole type on beam	:	Standard (STD)

Column side

Weld to support	:	E70XX
D1: Weld size to support (1/16in)	:	5

Stiffeners

Ns: Transverse stiffeners	:	None

Design code: AISC 360-16 LRFD

DEMANDS

Description	Ru [kip]	Pu [kip]	Mu [kip*ft]	PufTop [kip]	PufBot [kip]	Load type
DL	0.00	27.31	7.28	1.18	26.13	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Cap Plate						
Bolt diameter	[in]	1.00	--	1.50	✔	DG4 Sec. 1.1
Transverse center-to-center spacing (gage)	[in]	4.25	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
Transverse edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
Longitudinal edge distance	[in]	1.75	1.25	--	✔	Tables J3.4, J3.5
Beam						
Transverse edge distance	[in]	1.25	1.25	--	✔	Tables J3.4, J3.5
Plate (support side)						
Distance from centerline of bolt to nearer surface o...	[in]	1.75	1.50	--	✔	DG4 Sec. 2.1
Weld size	[1/16in]	5	2	--	✔	table J2.4

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Cap Plate						
Resulting tension capacity due prying action	[Kip]	97.02	26.13	DL	**0.27**	p. 9-10
Beam						
Bending	[Kip*ft]	153.56	7.28	DL	**0.05**	Eq. F13-1
Resulting tension capacity due prying action	[Kip]	30.12	26.13	DL	**0.87**	p. 9-12, p. 9-10
Local web yielding	[Kip]	113.83	0.00	DL	**0.00**	DG4 eq. 3.24
Web crippling	[Kip]	80.91	0.00	DL	**0.00**	Eq. J10-4
Compression buckling of the web	[Kip]	48.99	0.00	DL	**0.00**	Eq. J10-8
Support						
Weld capacity	[Kip]	48.72	26.13	DL	**0.54**	Eq. J2-3
Side wall local crippling	[Kip]	143.87	0.00	DL	**0.00**	Eq. J10-4
Side wall local yielding	[Kip]	75.03	0.00	DL	**0.00**	Eq. J4-1

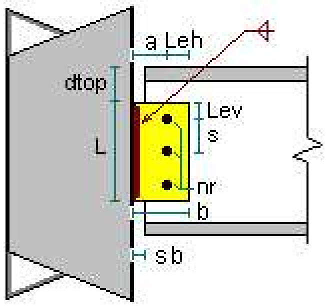
Global critical strength ratio **0.87**

Connection name : SP BCW
Connection ID : 4V

Family: Beam - Column web (BCW)
Type: Single plate

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 14X30
Beam material	:	A992 Gr50
sb: Beam setback	:	0.5 in
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
Horizontal eccentricity	:	0 in

Coped

dct: Top cope depth	:	0 in
ct: Top cope length	:	0 in
dcb: Bottom cope depth	:	0 in
cb: Bottom cope length	:	0 in

Column

General

Support section	:	HSS_SQR 7X7X1_4
Support material	:	A500 GrB rectangular

SINGLE PLATE

Connector

Section	:	PL 1/4x4x9
b: Width	:	4 in
L: Length	:	9 in
tp: Plate thickness	:	0.25 in
Material	:	A36
Plate position on beam	:	Center
Bolts	:	3/4" A325 N
nr: Rows of Bolts	:	3
nc: Bolt columns	:	1
s: Pitch - longitudinal center-to-center spacing	:	3 in
Lev: Vertical edge distance	:	1.5 in
Leh: Horizontal edge distance	:	1.5 in
a: Distance between weld and bolts	:	2.5 in
Hole type on plate	:	Standard (STD)
Hole type on beam	:	Standard (STD)
Welding electrode to support	:	E70XX
D: Weld size to support (1/16 in)	:	3
Wo: Obtuse side weld size (AWS) (1/16 in)	:	3
Wa: Acute side weld size (AWS) (1/16 in)	:	3
Wo: Obtuse side weld size (AISC) (1/16 in)	:	3
Wa: Acute side weld size (AISC) (1/16 in)	:	3

Design code: AISC 360-16 LRFD

DEMANDS

Description	Beam Ru [kip]	Beam Pu [kip]	Column Pu [kip]	Column Mu22 [kip*ft]	Column Mu33 [kip*ft]	Load type
DL	8.39	0.00	-9.21	13.81	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
<u>Shear plate</u>						
Thickness	[in]	0.25	--	0.32	✔	p. 10-103
Length	[in]	9.00	6.11	12.23	✔	p. 10-104
Thickness, precludes a punching failure of the HSS...	[in]	0.25	--	--	✔	
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-103
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
<u>Beam</u>						
Vertical edge distance	[in]	3.90	1.00	--	✔	Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.50	--	✔	p. 10-103
<u>Support</u>						
Maximum value of the specified yield stress	[Kip/in2]	46.00	--	--	✔	
Yield stress to tensile stress ratio		0.79	--	0.80	✔	Table K2.1A, Table K2.1
Weld size	[1/16in]	3	3	--	✔	p. 10-87
Weld length	[in]	9.00	0.75	--	✔	Sec. J2.2b

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
<u>Shear plate</u>						
Bolts shear	[Kip]	35.39	8.39	DL	0.24	Tables (7-1..14)
Bolt bearing under shear load	[Kip]	35.21	8.39	DL	0.24	p. 7-18, Sec. J3.10
Shear yielding	[Kip]	48.60	8.39	DL	0.17	Eq. J4-3
Shear rupture	[Kip]	41.60	8.39	DL	0.20	Eq. J4-4
Block shear	[Kip]	41.93	8.39	DL	0.20	Eq. J4-5
Flexural rupture	[Kip]	65.25	8.39	DL	0.13	p. 9-10
<u>Plate (support side)</u>						
Weld capacity	[Kip]	75.17	8.39	DL	0.11	Tables 8-4 .. 8-11
Shear yielding/buckling and flexure yielding		1.00	0.05	DL	0.05	Eq. 10-5
<u>Beam</u>						
Bolt bearing under shear load	[Kip]	46.84	8.39	DL	0.18	p. 7-18, Sec. J3.10
Shear yielding	[Kip]	111.78	8.39	DL	0.08	Eq. J4-3
<u>Support</u>						
Welds rupture	[Kip/ft]	97.30	7.46	DL	0.08	p. 9-5
Chord wall plastification	[Kip]	16.35	0.00	DL	0.00	Eq. J4-5
Punching shear (shear rupture)	[Kip]	65.68	8.39	DL	0.13	p. 10-153
Global critical strength ratio	**0.24**					

NOTES

The plate is designed with the extended configuration criteria.

REFERENCES

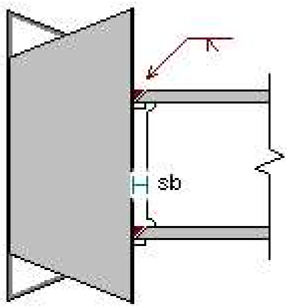
[4] AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Connection name : DW BCW
Connection ID : 6M

Family: Beam - Column web (BCW)
Type: Directly welded flanges

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 12X14
Beam material	:	A992 Gr50
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
sb: Beam setback	:	0.5 in

Column

General

Support section	:	HSS_SQR 7X7X1_4
Support material	:	A500 GrB rectangular

Design code: AISC 360-16 LRFD

DEMANDS

Description	Ru [kip]	Pu [kip]	Mu [kip*ft]	PufTop [kip]	PufBot [kip]	Load type
DL	0.00	0.00	10.20	-10.49	10.49	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Support						
Flange wall slenderness		30.04	--	--	✓	
Web wall slenderness		30.04	--	--	✓	
Beam flange / support width ratio		0.57	--	--	✓	
Yield stress	[Kip/in2]	46.00	--	--	✓	
Yield stress to tensile stress ratio		0.79	--	0.80	✓	Table K2.1A, Table K2.1

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Support						
Local yielding due to uneven load distribution	[Kip]	12.75	10.49	DL	**0.82**	Eq. J4-1
Side wall local yielding	[Kip]	42.28	10.49	DL	**0.25**	Eq. J4-3
Side wall local buckling	[Kip]	100.17	10.49	DL	**0.10**	Eq. J10-8

Global critical strength ratio **0.82**

Parking Cover Member Results and Connection Design

Nodal loads and displacements, distributed loads, material take off, member internal forces results, and connection design results are shown in the following documents.

ECONOMICAL JOIST GUIDE
Combined K, VS, LH & DLH Series Load Table

10' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
10K 1	550	550	5.0

11' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
10K 1	550	542	5.0

12' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
10K 1	550	455	5.0

13' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
10K 1	479	363	5.0
12K 1	550	510	5.0

14' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
10K 1	412	289	5.0
14K 1	550	550	5.2

15' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
10K 1	358	234	5.0
12K 1	434	344	5.0
14K 1	511	475	5.2
14K 3	550	507	5.9

16' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
10K 1	313	192	5.0
12K 1	380	282	5.0
14K 1	448	390	5.2
12K 3	476	351	5.7
14K 3	550	467	5.9

17' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
10K 1	277	159	5.0
12K 1	336	234	5.0
14K 1	395	324	5.2
12K 3	420	291	5.7
16K 2	512	488	5.5
16K 3	550	526	6.3

18' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
10K 1	246	134	5.0
12K 1	299	197	5.0
14K 1	352	272	5.2
12K 3	374	245	5.5
14K 3	441	339	5.8
16K 2	456	409	5.5
16K 3	508	456	6.3
14K 4	530	397	6.7
14K 6	550	408	6.9

19' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
10K1	221	113	5.0
12K1	268	167	5.0
14K1	315	230	5.2
12K3	335	207	5.6
16K2	408	347	5.5
16K3	455	386	6.3
18K3	514	494	6.6
16K4	547	452	7.0
16K5	550	455	7.2

20' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
12K 1	241	142	5.0
14K 1	284	197	5.2
12K 3	302	177	5.5

20' LENGTH (Cont.)

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
16K2	368	297	5.5
16K3	410	330	6.2
18K3	463	423	6.5
16K4	493	386	7.0
16K5	550	426	7.5

21' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
12K1	218	123	5.0
14K1	257	170	5.2
12K3	273	153	5.5
14K3	322	212	5.7
16K2	333	255	5.5
16K3	371	285	6.3
18K3	420	364	6.6
16K4	447	333	7.0
20K3	468	453	6.7
16K5	503	373	7.5
18K4	506	426	7.2
20K4	550	520	7.6

22' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
12K1	199	106	5.0
14K1	234	147	5.1
12K3	249	132	5.5
14K3	293	184	5.6
16K2	303	222	5.5
16K3	337	247	6.2
18K3	382	316	6.5
16K4	406	289	6.9
20K3	426	393	6.7
18K4	460	370	7.2
20K4	514	461	7.6
18K5	518	414	7.7
22K6	550	548	7.5
18LH2	554	439	8.8
18LH3	614	488	10
18LH4	715	566	11
18LH5	808	637	12
18LH6	955	738	14
18LH7	992	776	15
18LH8	1034	810	15
18LH9	1108	864	16

23' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
14K1	214	128	5.1
12K3	227	116	5.5
16K2	277	194	5.5
16K3	308	216	6.0
18K3	349	276	6.6
16K4	371	252	7.0
20K3	389	344	6.7
18K4	420	323	7.2
20K4	469	402	7.6
18K5	473	362	7.7
22K6	550	518	7.7
18LH3	587	446	10
18LH4	684	517	11
20LH5	697	589	11
18LH5	772	582	13
18LH6	913	674	15
18LH7	949	709	15
20LH8	1024	858	15
18LH9	1059	790	16
20LH9	1121	935	16
20LH10	1209	1008	17

24' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
14K1	196	113	5.1
12K3	208	101	5.6

24' LENGTH (Cont.)

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
16K2	254	170	5.5
16K3	283	189	6.1
18K3	320	242	6.5
16K4	340	221	6.9
20K3	357	302	6.7
18K4	385	284	7.2
20K4	430	353	7.6
18K5	434	318	7.7
18K6	473	345	8.5
20K5	485	396	8.2
24K6	550	544	7.7
18LH3	562	409	10
20LH4	621	503	10
18LH4	655	474	11
20LH5	668	540	11
18LH5	739	534	12
18LH6	875	619	15
20LH6	892	713	15
18LH7	908	650	15
18LH8	946	679	16
20LH7	951	761	15
20LH8	980	787	16
18LH9	1014	725	17
20LH9	1073	857	16
20LH10	1158	924	17

25' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
14K1	180	100	5.1
16K2	234	150	5.5
16K3	260	167	5.9
18K3	294	214	6.3
16K4	313	195	6.9
20K3	329	266	6.7
18K4	355	250	7.1
16K6	384	238	8.1
18K5	400	281	7.7
16K7	428	263	8.6
18K6	435	305	8.5
20K5	446	350	8.2
18K7	485	337	9.0
20K6	486	380	8.9
16K9	514	311	10
24K6	550	520	8.6
20LH4	596	463	10
18LH4	628	436	11
20LH5	641	497	11
18LH5	709	492	13
20LH6	855	656	15
18LH7	872	599	16
18LH8	908	625	16
20LH7	912	701	16
20LH8	941	724	16
18LH9	973	667	17
20LH9	1030	789	17
20LH10	1111	851	18

26' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
14K1	166	83	5.1
16K2	216	133	5.5
16K3	240	148	5.9
18K3	272	190	6.4
16K4	289	173	6.8
20K3	304	236	6.7
18K4	328	222	7.2
20K4	366	277	7.6
18K5	369	249	7.7
22K4	404	338	8.0
20K5	412	310	8.2
20K6	449	337	8.9
22K5	455	379	8.8
26K5	542	535	8.8

26' LENGTH (Cont.)

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
24K6	543	493	8.9
24K7	550	499	9.2
20LH4	574	428	11
18LH4	604	403	12
20LH5	616	459	11
18LH5	684	454	13
20LH6	822	606	15
18LH7	840	553	16
18LH8	876	577	16
20LH7	878	647	16
18LH9	936	616	17
20LH9	990	729	17
20LH10	1068	786	18

27' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
14K1	154	79	5.1
16K2	200	119	5.5
16K3	223	132	5.9
18K3	252	169	6.3
16K4	268	155	6.8
20K3	281	211	6.6
18K4	303	198	7.0
20K4	339	247	7.4
18K5	342	222	7.7
22K4	374	301	8.0
20K5	382	277	8.2
20K6	416	301	8.8
22K5	422	337	8.7
24K6	503	439	8.6
26K6	547	519	8.9
26K7	550	522	9.1
20LH4	566	406	11
18LH4	571	367	12
20LH5	609	437	12
18LH5	648	414	14
20LH6	791	561	15
20LH7	845	599	16
20LH8	873	619	16
20LH9	953	675	17
20LH10	1028	724	19

28' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
14K1	143	70	5.1
16K2	186	106	5.5
16K3	207	118	5.8
18K3	234	151	6.2
16K4	249	138	6.6
20K3	261	189	6.7
16K5	281	155	7.4
18K4	282	177	7.2
20K4	315	221	7.5
18K5	318	199	7.7
18K6	346	216	8.5
20K5	355	248	8.2
22K5	392	302	8.8
26K5	466	427	8.1
24K6	467	393	8.5
22K7	475	364	9.2
26K6	508	464	8.9
28K6	548	541	9.2
28K7	550	543	9.2
20LH4	558	386	12
20LH5	602	416	13
18LH5	614	378	14
20LH6	763	521	15
20LH7	814	556	16
20LH8	842	575	17
20LH9	918	626	18
20LH10	991	673	20

NUCOR VULCRAFT GROUP

Member Distributed Loads (BLC 1 : DL)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […]	End Location [(…	Inactive [(k, k-f…
1	M16	Y	-0.198	-0.198	0	%100	Active
2	M17	Y	-0.198	-0.198	0	%100	Active
3	M24	Y	-0.198	-0.198	0	%100	Active
4	M23	Y	-0.198	-0.198	0	%100	Active
5	M20	Y	-0.198	-0.198	0	%100	Active
6	M18	Y	-0.198	-0.198	0	%100	Active
7	M19	Y	-0.198	-0.198	0	%100	Active
8	M21	Y	-0.198	-0.198	0	%100	Active

Member Distributed Loads (BLC 5 : RLL)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […]	End Location [(…	Inactive [(k, k-f…
1	M23	Y	-0.198	-0.198	0	%100	Active
2	M24	Y	-0.198	-0.198	0	%100	Active
3	M16	Y	-0.198	-0.198	0	%100	Active
4	M17	Y	-0.198	-0.198	0	%100	Active
5	M20	Y	-0.198	-0.198	0	%100	Active
6	M18	Y	-0.198	-0.198	0	%100	Active
7	M19	Y	-0.198	-0.198	0	%100	Active
8	M21	Y	-0.198	-0.198	0	%100	Active

Node Loads and Enforced Displacements (BLC 4 : ELX)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N10	L	X	20.79	Active

Node Loads and Enforced Displacements (BLC 6 : ELZ)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N10	L	Z	20.79	Active

Node Loads and Enforced Displacements (BLC 7 : Wind Load Z)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N10	L	Z	1.864	Active

Node Loads and Enforced Displacements (BLC 8 : Wind Load X)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N10	L	X	16.451	Active

Node Loads and Enforced Displacements (BLC 9 : Partial Z Wind Load 1)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N21	L	Z	1.398	Active

Node Loads and Enforced Displacements (BLC 10 : Partial Z Wind Load 2)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N22	L	Z	1.398	Active

Node Loads and Enforced Displacements (BLC 11 : Partial X Wind Load 1)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N23	L	X	12.338	Active

Node Loads and Enforced Displacements (BLC 12 : Partial X Wind Load 2)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N24	L	X	12.338	Active

Load Combinations

	De…	So…	PD…	SR…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…
1	De…	Yes	Y		DL	1																		
2	De…	Yes	Y		LL	1																		
3	De…	Yes	Y		DL	1	LL	1																
4	IB…	Yes	Y		DL	1.4																		
5	IB…	Yes	Y		DL	1.2	LL	1.6	LLS	1.6	RLL	0.5												
6	IB…	Yes	Y		DL	1.2	LL	1.6	LLS	1.6														
7	IB…	Yes	Y		DL	1.2	RLL	1.6	LL	0.5	LLS	1												
8	IB…	Yes	Y		DL	1.2	RLL	1.6	WLX	0.5														
9	IB…	Yes	Y		DL	1.2	RLL	1.6	W…	0.5														
10	IB…	Yes	Y		DL	1.2	RLL	1.6	W…	0.5														
11	IB…	Yes	Y		DL	1.2	RLL	1.6	WLZ	0.5														
12	IB…	Yes	Y		DL	1.2	RLL	1.6	W…	0.5														
13	IB…	Yes	Y		DL	1.2	RLL	1.6	W…	0.5														
14	IB…	Yes	Y		DL	1.2	WLX	0.5																
15	IB…	Yes	Y		DL	1.2	W…	0.5																
16	IB…	Yes	Y		DL	1.2	W…	0.5																
17	IB…	Yes	Y		DL	1.2	WLZ	0.5																
18	IB…	Yes	Y		DL	1.2	W…	0.5																
19	IB…	Yes	Y		DL	1.2	W…	0.5																
20	IB…	Yes	Y		DL	1.2	WLX	1	LL	0.5	LLS	1	RLL	0.5										
21	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	RLL	0.5										
22	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	RLL	0.5										
23	IB…	Yes	Y		DL	1.2	WLZ	1	LL	0.5	LLS	1	RLL	0.5										
24	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	RLL	0.5										
25	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	RLL	0.5										
26	IB…	Yes	Y		DL	1.2	WLX	1	LL	0.5	LLS	1												
27	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1												
28	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1												
29	IB…	Yes	Y		DL	1.2	WLZ	1	LL	0.5	LLS	1												
30	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1												
31	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1												
32	IB…	Yes	Y		DL	0.9	WLX	1																
33	IB…	Yes	Y		DL	0.9	W…	1																
34	IB…	Yes	Y		DL	0.9	W…	1																
35	IB…	Yes	Y		DL	0.9	WLZ	1																
36	IB…	Yes	Y		DL	0.9	W…	1																
37	IB…	Yes	Y		DL	0.9	W…	1																
38	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
39	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
40	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
41	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
42	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
43	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
44	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
45	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
46	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
47	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
48	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
49	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
50	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
51	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
52	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
53	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
54	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
55	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
56	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												
57	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												
58	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												

Load Combinations (Continued)

	De…	So…	PD…	SR…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…
59	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												
60	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												
61	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												

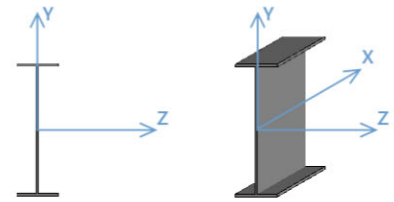
Node Reactions

	Node…		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
1	N17	max	1.283	49	19.447	9	1.263	44	12.8	44	0.554	21	43.85	44
2		min	-4.277	44	0	2	-4.211	47	-42.668	47	-0.554	22	-13.156	48
3	N13	max	1.239	61	43.837	8	1.243	56	12.771	44	0.554	21	43.494	44
4		min	-4.13	56	0	2	-4.145	59	-42.572	47	-0.554	22	-13.049	48
5	N9	max	1.231	59	50.71	13	1.24	56	12.762	44	0.554	21	43.374	44
6		min	-4.103	56	0	2	-4.133	59	-42.541	47	-0.554	22	-13.014	47
7	N5	max	1.239	59	43.837	13	1.243	56	12.771	44	0.554	21	43.482	38
8		min	-4.129	50	0	2	-4.145	59	-42.572	47	-0.554	22	-13.048	47
9	N1	max	1.283	47	19.447	10	1.263	44	12.8	44	0.554	21	43.829	38
10		min	-4.275	38	0	2	-4.211	47	-42.668	47	-0.554	22	-13.155	47
11	N11	max	NC		NC		NC		NC		NC		LOCK…	
12		min	NC		NC		NC		NC		NC		LOCK…	
13	N12	max	NC		NC		NC		NC		NC		LOCK…	
14		min	NC		NC		NC		NC		NC		LOCK…	
15	Totals:	max	6.238	47	177.278	13	6.237	44						
16		min	-20.793	44	0	2	-20.79	47						

Material Take-Off

	Material	Size	Pieces	Length [ft]	Weight [k]
1	Hot Rolled Steel				
2	A500 Gr.B Rect	HSS4X4X4	10	70.7	0.872
3	A500 Gr.B Rect	HSS9X9X8	10	50	2.8
4	A992	W21X44	24	214.3	9.479
5	A992	W21X68	4	153.4	10.438
6	Total HR Steel		48	488.4	23.589

Detail Report: M16 **Load Combination:** Envelope



Input Data:

Shape:	W21X44	I Node:	N3
Member Type:	Beam	J Node:	N7
Length (ft):	28.833	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

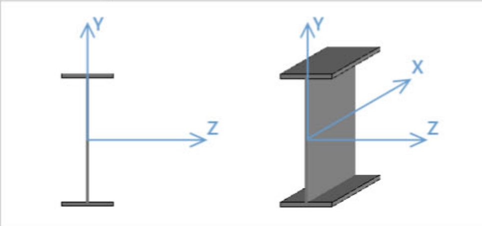
Design Properties:

$L_{b\ y\text{-}y}$ (ft) :	28.833	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/716
$L_{b\ z\text{-}z}$ (ft) :	28.833	$K_{z\text{-}z}$:	1	Max Defl Location:	14.271
$L_{comp\ top}$ (ft) :	28.833	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft) :	28.833	z sway:	No		
L_{torque} (ft) :	28.833	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	13	-	-	-	-
Applied Loading - Shear	13	-	-	-	-
Axial Tension Analysis	13	0.000 k	585 k	-	-
Axial Compression Analysis	13	0.000 k	39.063 k	-	-
Flexural Analysis (Strong Axis)	13	63.122 k-ft	70.156 k-ft	-	-
Flexural Analysis (Weak Axis)	13	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	13	8.758 k	217.35 k	0.04	**Pass**
Shear Analysis (Minor Axis z)	13	0.000 k	157.95 k	0.000	**Pass**
Bending & Axial Interaction Check (UC Bending Max)	13	-	-	0.9	**Pass**

Detail Report: M18 **Load Combination:** Envelope



Input Data:

Shape:	W21X68	I Node:	N7
Member Type:	Beam	J Node:	N11
Length (ft):	38.344	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	21.1	Area (in^2):	20	S_w (in^4):	59.8
b_f (in):	8.27	Z_{yy} (in^3):	24.4	r_T (in):	2.12
t_f (in):	0.685	Z_{zz} (in^3):	160	J (in^4):	2.45
t_w (in):	0.43	C_w (in^6):	6760	k_{det} (in):	1.375
I_{yy} (in^4):	64.7	W_{no} (in^2):	42.2	k_{des} (in):	1.19
I_{zz} (in^4):	1480				

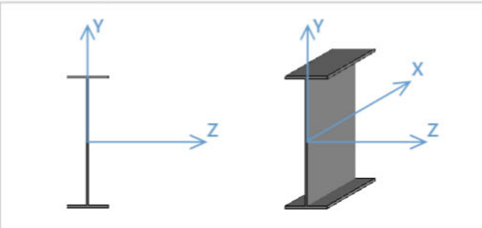
Design Properties:

$L_{b\ y\text{-}y}$ (ft) :	38.344	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/510
$L_{b\ z\text{-}z}$ (ft) :	38.344	$K_{z\text{-}z}$:	1	Max Defl Location:	18.978
$L_{comp\ top}$ (ft) :	38.344	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft) :	38.344	z sway:	No		
L_{torque} (ft) :	38.344	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	13	-	-	-	-
Applied Loading - Shear	13	-	-	-	-
Axial Tension Analysis	13	0.000 k	900 k	-	-
Axial Compression Analysis	13	0.000 k	69.039 k	-	-
Flexural Analysis (Strong Axis)	13	116.885 k-ft	152.76 k-ft	-	-
Flexural Analysis (Weak Axis)	13	0.000 k-ft	91.5 k-ft	-	-
Shear Analysis (Major Axis y)	13	12.195 k	272.19 k	0.045	Pass
Shear Analysis (Minor Axis z)	13	0.000 k	305.907 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	13	-	-	0.765	Pass

Detail Report: M14 **Load Combination:** Envelope



Input Data:

Shape:	W21X44	I Node:	N3
Member Type:	Beam	J Node:	N26
Length (ft):	4.896	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5\circ}F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

Design Properties:

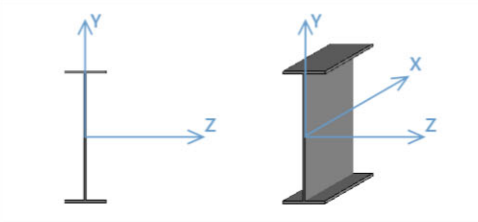
$L_{b\ y\text{-}y}$ (ft):	4.896	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/3150
$L_{b\ z\text{-}z}$ (ft):	4.896	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	4.896	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	4.896	z sway:	No		
L_{torque} (ft):	4.896	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	10	-	-	-	-
Applied Loading - Shear	10	-	-	-	-
Axial Tension Analysis	10	0.000 k	585 k	-	-
Axial Compression Analysis	10	0.000 k	433.487 k	-	-
Flexural Analysis (Strong Axis)	10	43.513 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	10	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	10	9.018 k	217.35 k	0.041	Pass
Shear Analysis (Minor Axis z)	10	0.000 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	10	-	-	0.122	Pass

Detail Report: M15

Load Combination: Envelope



Input Data:

Shape:	W21X44	I Node:	N26
Member Type:	Beam	J Node:	N2
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. $(1e^{5}{}^{\circ}F^{-1})$:	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

Design Properties:

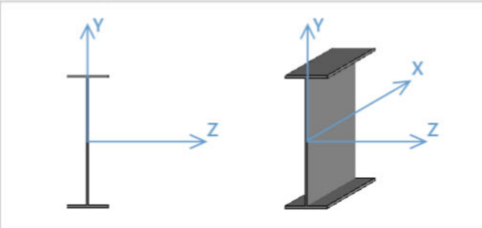
$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/6324
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	2.374
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	9	-	-	-	-
Applied Loading - Shear	11	-	-	-	-
Axial Tension Analysis	9	0.000 k	585 k	-	-
Axial Compression Analysis	9	0.000 k	431.09 k	-	-
Flexural Analysis (Strong Axis)	9	43.513 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	9	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	11	4.201 k	217.35 k	0.019	**Pass**
Shear Analysis (Minor Axis z)	11	0.035 k	157.95 k	0.000	**Pass**
Bending & Axial Interaction Check (UC Bending Max)	9	-	-	0.122	**Pass**

Detail Report: M22

Load Combination: Envelope



Input Data:

Shape:	W21X44	I Node:	N2
Member Type:	Beam	J Node:	N27
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}{}^\circ F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

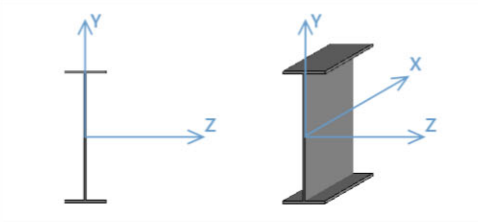
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/6506
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	2.626
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	9	-	-	-	-
Applied Loading - Shear	9	-	-	-	-
Axial Tension Analysis	9	0.000 k	585 k	-	-
Axial Compression Analysis	9	0.000 k	431.09 k	-	-
Flexural Analysis (Strong Axis)	9	43.513 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	9	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	9	4.581 k	217.35 k	0.021	Pass
Shear Analysis (Minor Axis z)	9	0.026 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	9	-	-	0.122	Pass

Detail Report: M25 **Load Combination:** Envelope



Input Data:

Shape:	W21X44	I Node:	N27
Member Type:	Beam	J Node:	N4
Length (ft):	4.896	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

Design Properties:

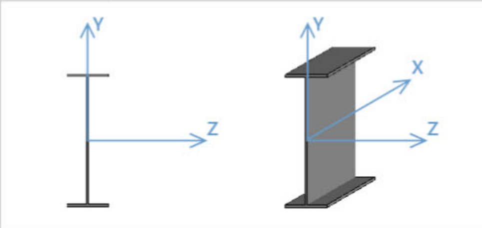
$L_{b\ y\text{-}y}$ (ft):	4.896	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/3150
$L_{b\ z\text{-}z}$ (ft):	4.896	$K_{z\text{-}z}$:	1	Max Defl Location:	4.896
$L_{comp\ top}$ (ft):	4.896	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	4.896	z sway:	No		
L_{torque} (ft):	4.896	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	9	-	-	-	-
Applied Loading - Shear	8	-	-	-	-
Axial Tension Analysis	9	0.000 k	585 k	-	-
Axial Compression Analysis	9	0.000 k	433.487 k	-	-
Flexural Analysis (Strong Axis)	9	43.513 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	9	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	8	9.018 k	217.35 k	0.041	Pass
Shear Analysis (Minor Axis z)	8	0.000 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	9	-	-	0.122	Pass

Detail Report: M26

Load Combination: Envelope



Input Data:

Shape:	W21X44	I Node:	N7
Member Type:	Beam	J Node:	N29
Length (ft):	4.896	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}{}^{\circ}F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

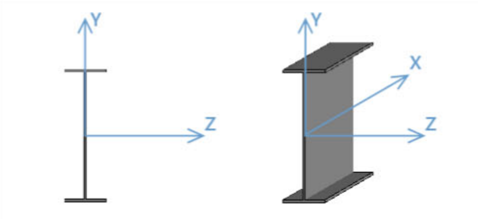
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	4.896	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/1325
$L_{b\ z\text{-}z}$ (ft):	4.896	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	4.896	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	4.896	z sway:	No		
L_{torque} (ft):	4.896	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	9	-	-	-	-
Applied Loading - Shear	12	-	-	-	-
Axial Tension Analysis	9	0.000 k	585 k	-	-
Axial Compression Analysis	9	0.000 k	433.487 k	-	-
Flexural Analysis (Strong Axis)	9	103.215 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	9	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	12	21.212 k	217.35 k	0.098	Pass
Shear Analysis (Minor Axis z)	12	0.000 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	9	-	-	0.289	Pass

Detail Report: M27 **Load Combination:** Envelope



Input Data:

Shape:	W21X44	I Node:	N29
Member Type:	Beam	J Node:	N6
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}{}^{\circ}F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

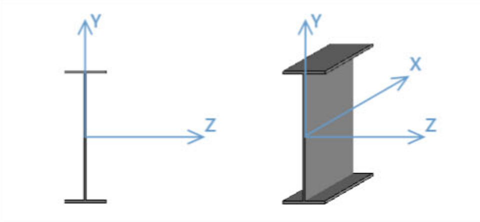
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/2719
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	2.374
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	9	-	-	-	-
Applied Loading - Shear	11	-	-	-	-
Axial Tension Analysis	9	0.000 k	585 k	-	-
Axial Compression Analysis	9	0.000 k	431.09 k	-	-
Flexural Analysis (Strong Axis)	9	103.215 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	9	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	11	9.865 k	217.35 k	0.045	Pass
Shear Analysis (Minor Axis z)	11	0.035 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	9	-	-	0.289	Pass

Detail Report: M28 **Load Combination:** Envelope



Input Data:

Shape:	W21X44	I Node:	N6
Member Type:	Beam	J Node:	N30
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5\circ}F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

Design Properties:

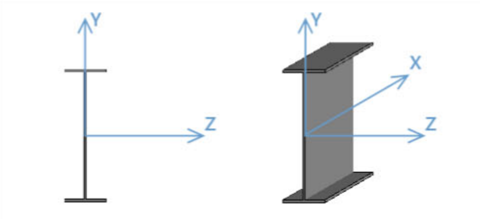
$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/2748
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	2.626
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	9	-	-	-	-
Applied Loading - Shear	9	-	-	-	-
Axial Tension Analysis	9	0.000 k	585 k	-	-
Axial Compression Analysis	9	0.000 k	431.09 k	-	-
Flexural Analysis (Strong Axis)	9	103.215 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	9	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	9	10.192 k	217.35 k	0.047	Pass
Shear Analysis (Minor Axis z)	9	0.026 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	9	-	-	0.289	Pass

Detail Report: M29

Load Combination: Envelope



Input Data:

Shape:	W21X44	I Node:	N30
Member Type:	Beam	J Node:	N8
Length (ft):	4.896	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

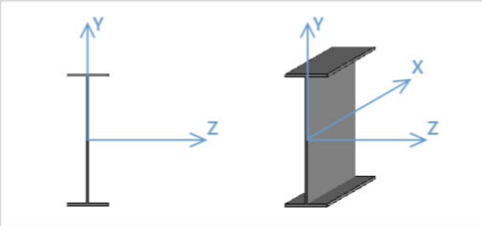
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	4.896	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/1325
$L_{b\ z\text{-}z}$ (ft):	4.896	$K_{z\text{-}z}$:	1	Max Defl Location:	4.896
$L_{comp\ top}$ (ft):	4.896	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	4.896	z sway:	No		
L_{torque} (ft):	4.896	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	8	-	-	-	-
Applied Loading - Shear	8	-	-	-	-
Axial Tension Analysis	8	0.000 k	585 k	-	-
Axial Compression Analysis	8	0.000 k	433.487 k	-	-
Flexural Analysis (Strong Axis)	8	103.215 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	8	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	8	21.212 k	217.35 k	0.098	Pass
Shear Analysis (Minor Axis z)	8	0.000 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	8	-	-	0.289	Pass

Detail Report: M30 **Load Combination:** Envelope



Input Data:

Shape:	W21X44	I Node:	N11
Member Type:	Beam	J Node:	N32
Length (ft):	4.896	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$ °F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

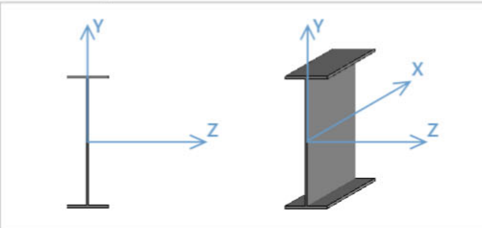
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	4.896	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/1139
$L_{b\ z\text{-}z}$ (ft):	4.896	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	4.896	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	4.896	z sway:	No		
L_{torque} (ft):	4.896	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	8	-	-	-	-
Applied Loading - Shear	13	-	-	-	-
Axial Tension Analysis	8	0.000 k	585 k	-	-
Axial Compression Analysis	8	0.000 k	433.487 k	-	-
Flexural Analysis (Strong Axis)	8	120.041 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	8	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	13	24.649 k	217.35 k	0.113	Pass
Shear Analysis (Minor Axis z)	13	0.000 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	8	-	-	0.336	Pass

Detail Report: M31 **Load Combination:** Envelope



Input Data:

Shape:	W21X44	I Node:	N32
Member Type:	Beam	J Node:	N10
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5\circ}F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

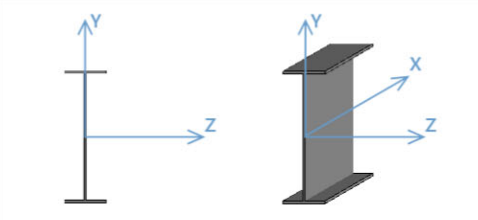
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/2344
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	2.374
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	10	-	-	-	-
Applied Loading - Shear	11	-	-	-	-
Axial Tension Analysis	10	0.036 k	585 k	-	-
Axial Compression Analysis	10	0.000 k	431.09 k	-	-
Flexural Analysis (Strong Axis)	10	120.041 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	10	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	11	11.461 k	217.35 k	0.053	Pass
Shear Analysis (Minor Axis z)	11	0.035 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	10	-	-	0.336	Pass

Detail Report: M32 **Load Combination:** Envelope



Input Data:

Shape:	W21X44	I Node:	N10
Member Type:	Beam	J Node:	N33
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}{}^{\circ}F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

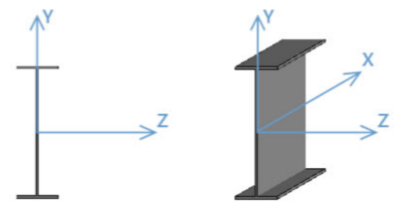
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/2366
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	2.626
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	10	-	-	-	-
Applied Loading - Shear	8	-	-	-	-
Axial Tension Analysis	10	0.000 k	585 k	-	-
Axial Compression Analysis	10	0.036 k	431.09 k	-	-
Flexural Analysis (Strong Axis)	10	120.041 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	10	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	8	11.763 k	217.35 k	0.054	Pass
Shear Analysis (Minor Axis z)	8	0.000 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	10	-	-	0.336	Pass

Detail Report: M33 **Load Combination:** Envelope



Input Data:

Shape:	W21X44	I Node:	N33
Member Type:	Beam	J Node:	N12
Length (ft):	4.896	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}{}^{\circ}F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	20.7	Area (in^2):	13	S_w (in^4):	24.1
b_f (in):	6.5	Z_{yy} (in^3):	10.2	r_T (in):	1.57
t_f (in):	0.45	Z_{zz} (in^3):	95.4	J (in^4):	0.77
t_w (in):	0.35	C_w (in^6):	2110	k_{det} (in):	1.125
I_{yy} (in^4):	20.7	W_{no} (in^2):	32.9	k_{des} (in):	0.95
I_{zz} (in^4):	843				

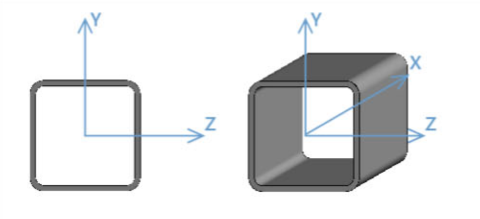
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	4.896	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/1139
$L_{b\ z\text{-}z}$ (ft):	4.896	$K_{z\text{-}z}$:	1	Max Defl Location:	4.896
$L_{comp\ top}$ (ft):	4.896	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	4.896	z sway:	No		
L_{torque} (ft):	4.896	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	9	-	-	-	-
Applied Loading - Shear	8	-	-	-	-
Axial Tension Analysis	9	0.000 k	585 k	-	-
Axial Compression Analysis	9	0.000 k	433.487 k	-	-
Flexural Analysis (Strong Axis)	9	120.041 k-ft	357.75 k-ft	-	-
Flexural Analysis (Weak Axis)	9	0.000 k-ft	38.215 k-ft	-	-
Shear Analysis (Major Axis y)	8	24.649 k	217.35 k	0.113	Pass
Shear Analysis (Minor Axis z)	8	0.000 k	157.95 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	9	-	-	0.336	Pass

Detail Report: M42 **Load Combination:** Envelope



Input Data:

Shape:	HSS9X9X8	I Node:	N1
Member Type:	Column	J Node:	N25
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	9	I_{yy} (in^4):	183	Area (in^2):	15.3
b_f (in):	9	I_{zz} (in^4):	183	J (in^4):	296
t (in):	0.465				

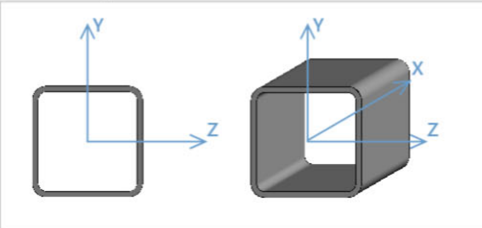
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/0
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	38	-	-	-	-
Applied Loading - Shear	21	-	-	-	-
Axial Tension Analysis	38	0.000 k	633.42 k	-	-
Axial Compression Analysis	38	12.032 k	620.724 k	-	-
Flexural Analysis (Strong Axis)	38	43.829 k-ft	166.98 k-ft	-	-
Flexural Analysis (Weak Axis)		12.8 k-ft	166.98 k-ft	-	-
Shear Analysis (Major Axis y)	21	4.675 k	175.685 k	0.027	Pass
Shear Analysis (Minor Axis z)	21	0.694 k	175.685 k	0.004	Pass
Bending & Axial Interaction Check (UC Bending Max)	38	-	-	0.349	Pass
Torsional Analysis		-	139.432 k-ft	-	-

Detail Report: M43 **Load Combination:** Envelope



Input Data:

Shape:	HSS9X9X8	I Node:	N25
Member Type:	Column	J Node:	N2
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^5 °F^{-1}$):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	9	I_{yy} (in^4):	183	Area (in^2):	15.3
b_f (in):	9	I_{zz} (in^4):	183	J (in^4):	296
t (in):	0.465				

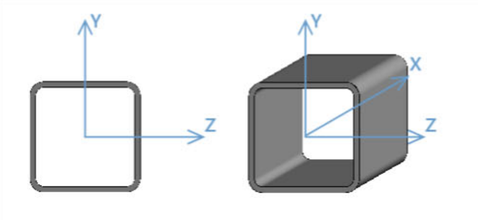
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/0
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	38	-	-	-	-
Applied Loading - Shear	21	-	-	-	-
Axial Tension Analysis	38	3.735 k	633.42 k	-	-
Axial Compression Analysis	38	0.000 k	620.724 k	-	-
Flexural Analysis (Strong Axis)	38	22.268 k-ft	166.98 k-ft	-	-
Flexural Analysis (Weak Axis)		6.419 k-ft	166.98 k-ft	-	-
Shear Analysis (Major Axis y)	21	6.333 k	175.685 k	0.036	Pass
Shear Analysis (Minor Axis z)	21	0.691 k	175.685 k	0.004	Pass
Bending & Axial Interaction Check (UC Bending Max)	38	-	-	0.175	Pass
Torsional Analysis		-	139.432 k-ft	-	-

Detail Report: M44 **Load Combination:** Envelope



Input Data:

Shape:	HSS9X9X8	I Node:	N5
Member Type:	Column	J Node:	N28
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	9	I_{yy} (in^4):	183	Area (in^2):	15.3
b_f (in):	9	I_{zz} (in^4):	183	J (in^4):	296
t (in):	0.465				

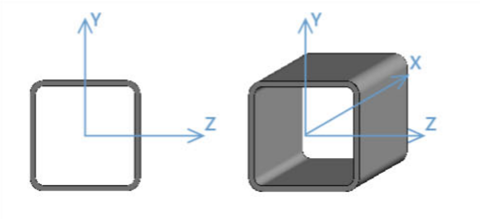
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/0
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	38	-	-	-	-
Applied Loading - Shear	41	-	-	-	-
Axial Tension Analysis	38	0.000 k	633.42 k	-	-
Axial Compression Analysis	38	26.314 k	620.724 k	-	-
Flexural Analysis (Strong Axis)	38	43.482 k-ft	166.98 k-ft	-	-
Flexural Analysis (Weak Axis)		12.771 k-ft	166.98 k-ft	-	-
Shear Analysis (Major Axis y)	41	1.255 k	175.685 k	0.007	Pass
Shear Analysis (Minor Axis z)	41	4.212 k	175.685 k	0.024	Pass
Bending & Axial Interaction Check (UC Bending Max)	38	-	-	0.358	Pass
Torsional Analysis		-	139.432 k-ft	-	-

Detail Report: M45 **Load Combination:** Envelope



Input Data:

Shape:	HSS9X9X8	I Node:	N28
Member Type:	Column	J Node:	N6
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	9	I_{yy} (in^4):	183	Area (in^2):	15.3
b_f (in):	9	I_{zz} (in^4):	183	J (in^4):	296
t (in):	0.465				

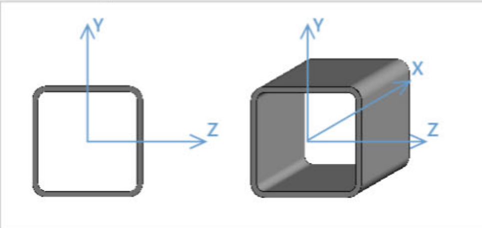
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/0
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	38	-	-	-	-
Applied Loading - Shear	38	-	-	-	-
Axial Tension Analysis	38	10.37 k	633.42 k	-	-
Axial Compression Analysis	38	0.000 k	620.724 k	-	-
Flexural Analysis (Strong Axis)	38	22.577 k-ft	166.98 k-ft	-	-
Flexural Analysis (Weak Axis)		6.443 k-ft	166.98 k-ft	-	-
Shear Analysis (Major Axis y)	38	6.163 k	175.685 k	0.035	Pass
Shear Analysis (Minor Axis z)	38	1.291 k	175.685 k	0.007	Pass
Bending & Axial Interaction Check (UC Bending Max)	38	-	-	0.182	Pass
Torsional Analysis		-	139.432 k-ft	-	-

Detail Report: M46 **Load Combination:** Envelope



Input Data:

Shape:	HSS9X9X8	I Node:	N9
Member Type:	Column	J Node:	N31
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	9	I_{yy} (in^4):	183	Area (in^2):	15.3
b_f (in):	9	I_{zz} (in^4):	183	J (in^4):	296
t (in):	0.465				

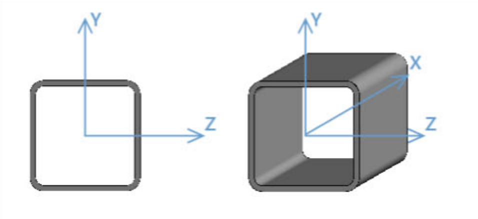
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/0
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	44	-	-	-	-
Applied Loading - Shear	41	-	-	-	-
Axial Tension Analysis	44	0.000 k	633.42 k	-	-
Axial Compression Analysis	44	30.818 k	620.724 k	-	-
Flexural Analysis (Strong Axis)	44	43.374 k-ft	166.98 k-ft	-	-
Flexural Analysis (Weak Axis)		12.762 k-ft	166.98 k-ft	-	-
Shear Analysis (Major Axis y)	41	1.242 k	175.685 k	0.007	Pass
Shear Analysis (Minor Axis z)	41	4.2 k	175.685 k	0.024	Pass
Bending & Axial Interaction Check (UC Bending Max)	44	-	-	0.361	Pass
Torsional Analysis		-	139.432 k-ft	-	-

Detail Report: M47 **Load Combination:** Envelope



Input Data:

Shape:	HSS9X9X8	I Node:	N31
Member Type:	Column	J Node:	N10
Length (ft):	5	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}°F^{-1}$):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	9	I_{yy} (in^4):	183	Area (in^2):	15.3
b_f (in):	9	I_{zz} (in^4):	183	J (in^4):	296
t (in):	0.465				

Design Properties:

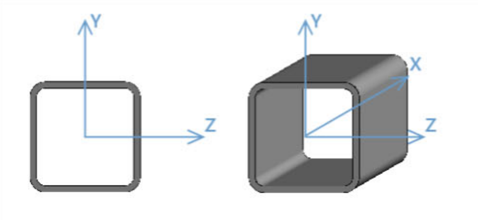
$L_{b\ y\text{-}y}$ (ft):	5	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/0
$L_{b\ z\text{-}z}$ (ft):	5	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	5	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	5	z sway:	No		
L_{torque} (ft):	5	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	44	-	-	-	-
Applied Loading - Shear	44	-	-	-	-
Axial Tension Analysis	44	12.463 k	633.42 k	-	-
Axial Compression Analysis	44	0.000 k	620.724 k	-	-
Flexural Analysis (Strong Axis)	44	22.677 k-ft	166.98 k-ft	-	-
Flexural Analysis (Weak Axis)		6.451 k-ft	166.98 k-ft	-	-
Shear Analysis (Major Axis y)	44	6.188 k	175.685 k	0.035	Pass
Shear Analysis (Minor Axis z)	44	1.293 k	175.685 k	0.007	Pass
Bending & Axial Interaction Check (UC Bending Max)	44	-	-	0.184	Pass
Torsional Analysis		-	139.432 k-ft	-	-

Detail Report: M52

Load Combination: Envelope



Input Data:

Shape:	HSS4X4X4	I Node:	N37
Member Type:	VBrace	J Node:	N39
Length (ft):	7.071	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	4	I_{yy} (in^4):	7.8	Area (in^2):	3.37
b_f (in):	4	I_{zz} (in^4):	7.8	J (in^4):	12.8
t (in):	0.233				

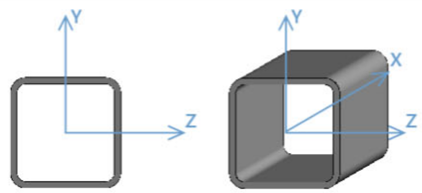
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	7.071	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/0
$L_{b\ z\text{-}z}$ (ft):	7.071	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	7.071	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	7.071	z sway:	No		
L_{torque} (ft):	7.071	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	10	-	-	-	-
Applied Loading - Shear	47	-	-	-	-
Axial Tension Analysis	10	0.000 k	139.518 k	-	-
Axial Compression Analysis	10	19.365 k	113.175 k	-	-
Flexural Analysis (Strong Axis)	10	0.000 k-ft	16.181 k-ft	-	-
Flexural Analysis (Weak Axis)		0.000 k-ft	16.181 k-ft	-	-
Shear Analysis (Major Axis y)	47	0.116 k	38.211 k	0.003	Pass
Shear Analysis (Minor Axis z)	47	0.073 k	38.211 k	0.002	Pass
Bending & Axial Interaction Check (UC Bending Max)	10	-	-	0.171	Pass
Torsional Analysis		-	13.587 k-ft	-	-

Detail Report: M54 **Load Combination:** Envelope



Input Data:

Shape:	HSS4X4X4	I Node:	N34
Member Type:	VBrace	J Node:	N36
Length (ft):	7.071	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	4	I_{yy} (in^4):	7.8	Area (in^2):	3.37
b_f (in):	4	I_{zz} (in^4):	7.8	J (in^4):	12.8
t (in):	0.233				

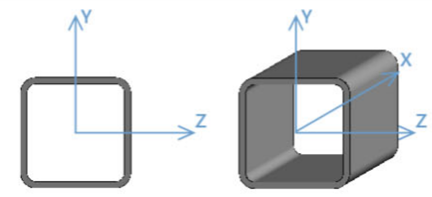
Design Properties:

$L_{b\ y-y}$ (ft):	7.071	K_{y-y}:	1	Max Defl Ratio:	L/0
$L_{b\ z-z}$ (ft):	7.071	K_{z-z}:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	7.071	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	7.071	z sway:	No		
L_{torque} (ft):	7.071	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	8	-	-	-	-
Applied Loading - Shear	47	-	-	-	-
Axial Tension Analysis	8	0.000 k	139.518 k	-	-
Axial Compression Analysis	8	44.601 k	113.175 k	-	-
Flexural Analysis (Strong Axis)	8	0.065 k-ft	16.181 k-ft	-	-
Flexural Analysis (Weak Axis)		0.000 k-ft	16.181 k-ft	-	-
Shear Analysis (Major Axis y)	47	0.116 k	38.211 k	0.003	Pass
Shear Analysis (Minor Axis z)	47	0.073 k	38.211 k	0.002	Pass
Bending & Axial Interaction Check (UC Bending Max)	8	-	-	0.398	Pass
Torsional Analysis		-	13.587 k-ft	-	-

Detail Report: M56 **Load Combination:** Envelope



Input Data:

Shape:	HSS4X4X4	I Node:	N31
Member Type:	VBrace	J Node:	N33
Length (ft):	7.071	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	10	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	4	I_{yy} (in^4):	7.8	Area (in^2):	3.37
b_f (in):	4	I_{zz} (in^4):	7.8	J (in^4):	12.8
t (in):	0.233				

Design Properties:

$L_{b\ y\text{-}y}$ (ft):	7.071	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/0
$L_{b\ z\text{-}z}$ (ft):	7.071	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	7.071	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	7.071	z sway:	No		
L_{torque} (ft):	7.071	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	8	-	-	-	-
Applied Loading - Shear	47	-	-	-	-
Axial Tension Analysis	8	0.000 k	139.518 k	-	-
Axial Compression Analysis	8	51.749 k	113.175 k	-	-
Flexural Analysis (Strong Axis)	8	0.065 k-ft	16.181 k-ft	-	-
Flexural Analysis (Weak Axis)		0.000 k-ft	16.181 k-ft	-	-
Shear Analysis (Major Axis y)	47	0.116 k	38.211 k	0.003	Pass
Shear Analysis (Minor Axis z)	47	0.073 k	38.211 k	0.002	Pass
Bending & Axial Interaction Check (UC Bending Max)	8	-	-	0.461	Pass
Torsional Analysis		-	13.587 k-ft	-	-

Current Date: 4/20/2021 12:14 PM
Units system: English
File name: E:\Parking Connections.rcnx

Steel connections

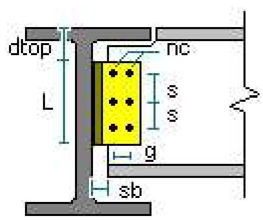
Detailed report

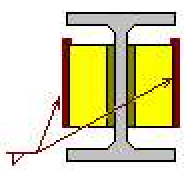
Connection name	:	**DA BG All bolted**
Connection ID	:	**1V**

Family: Beam - Girder (BG)
Type: Angle(s)

GENERAL INFORMATION

Connector





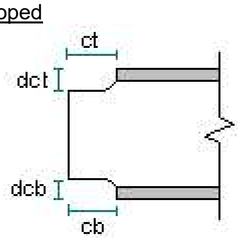
MEMBERS

Beam

General

Beam section	:	W 21X44
Beam material	:	A992 Gr50
Beam to girder alignment	:	Top
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
Horizontal eccentricity	:	0 in
sb: Beam setback	:	0.5 in

Coped



dct: Top cope depth	:	1.15 in
ct: Top cope length	:	3.57 in

dcb: Bottom cope depth	:	1.15 in
cb: Bottom cope length	:	3.57 in

Girder

General

Support section	:	W 21X44
Support material	:	A992 Gr50

ANGLE

Connector

Angle section	:	L 3X3X1_4
Material	:	A36
Angle short leg on beam	:	Yes
Consider double angle	:	Yes
Clearance	:	0.125 in
L: Angle length	:	12 in

Beam side

Angle position on beam	:	Center
dtop: Distance to beam top	:	2.5 in
Connection type	:	Bolted
Bolts	:	3/4" A325 N
nc: Bolt columns	:	1
nr: Rows of Bolts	:	4
s: Pitch - longitudinal center-to-center spacing	:	3 in
Lev: Vertical edge distance	:	1.5 in
Leh: Horizontal edge distance	:	1.25 in
Hole type on beam	:	Standard (STD)
Hole type on angle	:	Standard (STD)

Support side

Connection type	:	Welded
Welding electrode to support	:	E70XX
D2: Weld size to support (1/16 in)	:	3

Design code: AISC 360-16 LRFD

DEMANDS

Description	**Ru** [kip]	**Pu** [kip]	**Load type**
DL	8.76	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Angle						
Length	[in]	12.00	9.40	18.40	✔	p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
Thickness	[in]	0.25	--	0.63	✔	p. 10-9
Angle (Support side)						
Weld size	[1/16in]	3	2	3	✔	table J2.4, Sec. J2.2b
Weld length	[in]	12.00	0.75	--	✔	Sec. J2.2b
Beam						
Top cope length	[in]	3.57	--	41.40	✔	
Top cope depth	[in]	1.15	--	4.35	✔	
Bottom cope length	[in]	3.57	--	41.40	✔	
Bottom cope depth	[in]	1.15	--	4.35	✔	
Vertical edge distance	[in]	4.70	1.00	--	✔	Tables J3.4, J3.5
Horizontal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4, J3.5

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	143.21	8.76	DL	0.06	Tables (7-1..14)
Bolt bearing under shear load	[Kip]	146.00	8.76	DL	0.06	Eq. J3-6
Shear yielding	[Kip]	129.60	8.76	DL	0.07	Eq. J4-3
Shear rupture	[Kip]	110.93	8.76	DL	0.08	Eq. J4-4
Block shear	[Kip]	102.72	8.76	DL	0.09	Eq. J4-5
Angle (Support side)						
Weld capacity	[Kip]	74.50	8.76	DL	0.12	p. 10-11
Shear yielding	[Kip]	129.60	8.76	DL	0.07	Eq. J4-3
Beam						
Bolt bearing under shear load	[Kip]	122.85	8.76	DL	0.07	Eq. J3-6
Shear yielding	[Kip]	193.20	8.76	DL	0.05	Eq. J4-3
Shear rupture	[Kip]	152.54	8.76	DL	0.06	Eq. J4-4
Block shear	[Kip]	121.75	8.76	DL	0.07	Eq. J4-5
Flexural yielding	[Kip]	218.36	8.76	DL	0.04	p. 9-6
Flexural rupture	[Kip]	354.83	8.76	DL	0.02	p. 9-6
Local web buckling	[Kip]	324.55	8.76	DL	0.03	p. 9-7
Support						
Welds rupture	[Kip/ft]	163.80	7.86	DL	0.05	p. 9-5

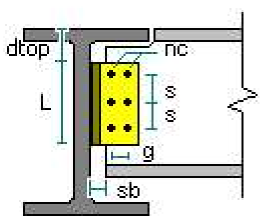
Global critical strength ratio **0.12**

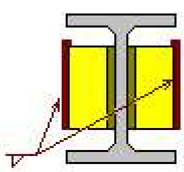
Connection name : DA BG Weld support Bolt beam
Connection ID : 2V

Family: Beam - Girder (BG)
Type: Angle(s)

GENERAL INFORMATION

Connector





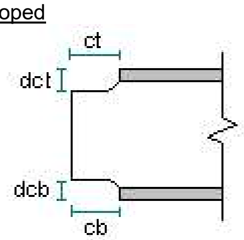
MEMBERS

Beam

General

Beam section	:	W 21X68
Beam material	:	A992 Gr50
Beam to girder alignment	:	Top
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
Horizontal eccentricity	:	0 in
sb: Beam setback	:	0.5 in

Coped



dct: Top cope depth	:	0.95 in
ct: Top cope length	:	3.075 in
dcb: Bottom cope depth	:	1.35 in
cb: Bottom cope length	:	3.075 in

Girder

General

Support section	:	W 21X44
Support material	:	A992 Gr50

ANGLE

Connector

Angle section	:	LU 3-1_2X3X1_4
Material	:	A36
Angle short leg on beam	:	Yes
Consider double angle	:	Yes
Clearance	:	0.125 in
L: Angle length	:	12 in

Beam side

Angle position on beam	:	Center
dtop: Distance to beam top	:	2.5 in
Connection type	:	Bolted
Bolts	:	3/4" A325 N
nc: Bolt columns	:	1
nr: Rows of Bolts	:	4
s: Pitch - longitudinal center-to-center spacing	:	3 in
Lev: Vertical edge distance	:	1.5 in
Leh: Horizontal edge distance	:	1.5 in
Hole type on beam	:	Standard (STD)
Hole type on angle	:	Standard (STD)

Support side

Connection type	:	Welded
Welding electrode to support	:	E70XX
D2: Weld size to support (1/16 in)	:	2

Design code: AISC 360-16 LRFD

DEMANDS

Description	Ru [kip]	Pu [kip]	Load type
DL	12.20	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Angle						
Length	[in]	12.00	9.36	18.56	✔	p. 10-8
Angle (Beam side)						
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
Thickness	[in]	0.25	--	0.63	✔	p. 10-9
Angle (Support side)						
Weld size	[1/16in]	2	2	3	✔	table J2.4, Sec. J2.2b
Weld length	[in]	12.00	0.50	--	✔	Sec. J2.2b
Beam						
Top cope length	[in]	3.08	--	42.20	✔	
Top cope depth	[in]	0.95	--	4.55	✔	
Bottom cope length	[in]	3.08	--	42.20	✔	
Bottom cope depth	[in]	1.35	--	4.55	✔	
Vertical edge distance	[in]	5.10	1.00	--	✔	Tables J3.4, J3.5
Horizontal edge distance	[in]	1.00	1.00	--	✔	Tables J3.4, J3.5

DESIGN CHECK

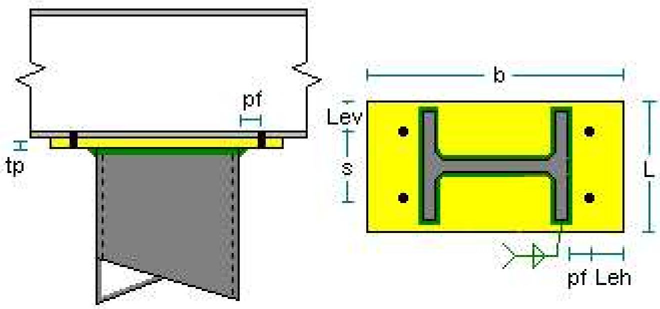
Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Angle (Beam side)						
Bolts shear	[Kip]	143.21	12.20	DL	0.09	Tables (7-1..14)
Bolt bearing under shear load	[Kip]	146.00	12.20	DL	0.08	Eq. J3-6
Shear yielding	[Kip]	129.60	12.20	DL	0.09	Eq. J4-3
Shear rupture	[Kip]	110.93	12.20	DL	0.11	Eq. J4-4
Block shear	[Kip]	108.16	12.20	DL	0.11	Eq. J4-5
Angle (Support side)						
Weld capacity	[Kip]	46.08	12.20	DL	0.26	p. 10-11
Shear yielding	[Kip]	129.60	12.20	DL	0.09	Eq. J4-3
Beam						
Bolt bearing under shear load	[Kip]	150.93	12.20	DL	0.08	Eq. J3-6
Shear yielding	[Kip]	242.52	12.20	DL	0.05	Eq. J4-3
Shear rupture	[Kip]	192.44	12.20	DL	0.06	Eq. J4-4
Block shear	[Kip]	148.21	12.20	DL	0.08	Eq. J4-5
Flexural yielding	[Kip]	318.84	12.20	DL	0.04	p. 9-6
Flexural rupture	[Kip]	518.11	12.20	DL	0.02	p. 9-6
Local web buckling	[Kip]	448.77	12.20	DL	0.03	p. 9-7
Support						
Welds rupture	[Kip/ft]	163.80	11.79	DL	0.07	p. 9-5
Global critical strength ratio	**0.26**					

Connection name : CP_5/8PL_2B3/4
Connection ID : 3

Family: Column cap (CC)
Type: Cap Plate

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 21X44
Beam material	:	A992 Gr50
Built-up	:	No

Column

General

Support section	:	HSS_SQR 9X9X1_2
Support material	:	A500 GrB rectangular
Column orientation	:	Longitudinal

CAP PLATE

Connector

tp: Plate thickness	:	0.625 in
Plate material	:	A36
Bolts	:	3/4" A325 N
Lev: Transverse distance to edge	:	2.375 in
Leh: Longitudinal distance to edge	:	1.25 in
pf: distance bolt centerline-tension flange	:	1.5 in
s: Transverse bolt spacing	:	4 in
Hole type on plate	:	Standard (STD)

Beam side

Hole type on beam	:	Standard (STD)

Column side

Weld to support	:	E70XX
D1: Weld size to support (1/16in)	:	5

Stiffeners

Ns: Transverse stiffeners	:	None

Design code: AISC 360-16 LRFD

DEMANDS

Description	Ru [kip]	Pu [kip]	Mu [kip*ft]	PufTop [kip]	PufBot [kip]	Load type
DL	0.00	-22.30	22.68	-41.39	19.08	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Cap Plate						
Bolt diameter	[in]	0.75	--	1.50	✔	DG4 Sec. 1.1
Transverse center-to-center spacing (gage)	[in]	4.00	2.00	12.00	✔	Sec. J3.3, Sec. J3.5
Transverse edge distance	[in]	2.38	1.00	--	✔	Tables J3.4, J3.5
Longitudinal edge distance	[in]	1.25	1.00	--	✔	Tables J3.4,

							J3.5
Beam							
Transverse edge distance	[in]	1.25	1.00		--	✔	Tables J3.4, J3.5
Plate (support side)							
Distance from centerline of bolt to nearer surface o...	[in]	1.50	1.25		--	✔	DG4 Sec. 2.1
Weld size	[1/16in]	5	3		--	✔	table J2.4

⚠ **WARNINGS**

- Support does not fit on plate

DESIGN CHECK

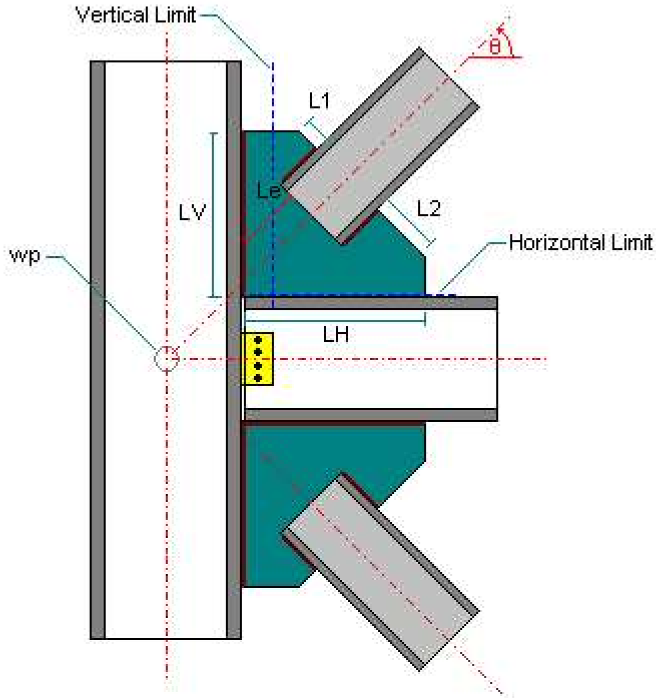
Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Cap Plate						
Resulting tension capacity due prying action	[Kip]	51.48	19.08	DL	0.37	p. 9-10
Beam						
Bending	[Kip*ft]	290.70	22.68	DL	0.08	Eq. F13-1
Resulting tension capacity due prying action	[Kip]	29.36	19.08	DL	0.65	p. 9-12, p. 9-10
Local web yielding	[Kip]	140.70	41.39	DL	0.29	DG4 eq. 3.24
Web crippling	[Kip]	111.23	41.39	DL	0.37	Eq. J10-4
Compression buckling of the web	[Kip]	59.32	41.39	DL	0.70	Eq. J10-8
Support						
Weld capacity	[Kip]	62.65	19.08	DL	0.30	Eq. J2-3
Side wall local crippling	[Kip]	693.97	41.39	DL	0.06	Eq. J10-4
Side wall local yielding	[Kip]	149.73	41.39	DL	0.28	Eq. J10-2
Global critical strength ratio	**0.70**					

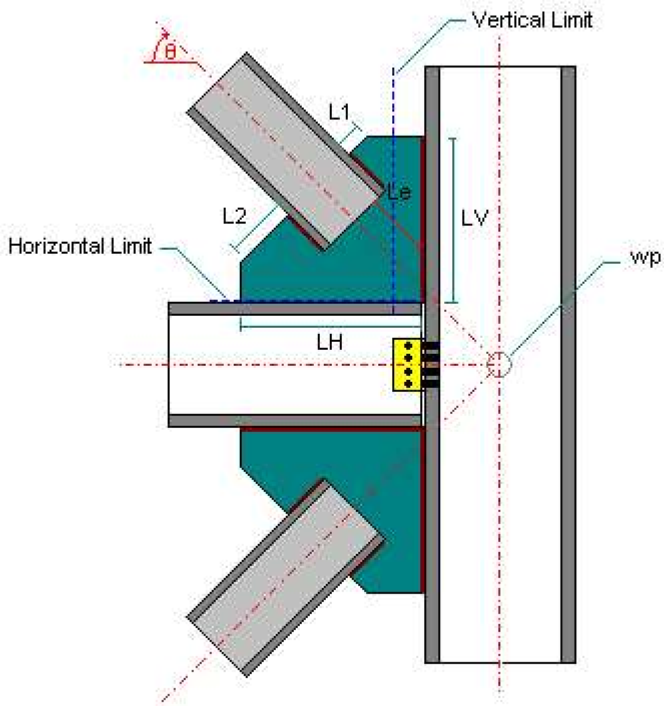
Connection name : CBB_DW_CBF
Connection ID : 4

Family: Column - Beams - Braces (CBB)
Type: Gusset

GENERAL INFORMATION

Connector





MEMBERS

Actual members

Right beam	:	No
Left beam	:	No
Upper right brace	:	Yes
Upper left brace	:	Yes
Lower left brace	:	No
Lower right brace	:	No
Align beams to top edge	:	No

Column

General

Column section	:	HSS_SQR 9X9X1_2
Column material	:	A500 GrB rectangular
Column orientation	:	Longitudinal
Is column end	:	No

Upper right brace

General

Section	:	HSS_SQR 4X4X1_4
Material	:	A500 GrB rectangular
Brace slope angle (degrees)	:	45
Brace long leg on gusset	:	Yes

Additional geometric data

wpx: WP horizontal displacement	:	0 in
wpy: WP vertical displacement	:	0 in
Le: Minimum distance to other members	:	2 in
L1: Left distance	:	2 in
L2: Right distance	:	2 in

Upper left brace

General

Section	:	HSS_SQR 4X4X1_4
Material	:	A500 GrB rectangular
Brace slope angle (degrees)	:	45
Brace long leg on gusset	:	Yes

Additional geometric data

wpx: WP horizontal displacement	:	0 in
wpy: WP vertical displacement	:	0 in
Le: Minimum distance to other members	:	2 in
L1: Left distance	:	2 in
L2: Right distance	:	2 in

INTERFACES

Upper right brace

Gusset

General

tp: Thickness	:	1 in
Material	:	A36
LV: Length on column	:	20.881 in

Gusset-to-Brace connection

General

Brace setback	:	0.75 in
Connection type	:	Bolted
Bolts	:	1" A490 X
Hole type	:	Standard (STD)
Hole type on gusset	:	Standard (STD)
nc: Bolt columns	:	2
nr: Rows of Bolts	:	1
s: Pitch - longitudinal center-to-center spacing	:	3 in
Leh: Longitudinal distance to edge	:	1.5 in
Lev: Transverse distance to edge	:	1.5 in
End connection type	:	Slotted
Material	:	A36
Plate thickness	:	0.563 in
Weld	:	E70XX
Weld size to brace (1/16 in)	:	4
Weld clearance	:	0.313 in
Weld lengh on brace	:	4 in

Gusset-to-Column connection

General

Connection type to column	:	Directly welded

Directly welded

Column weld	:	E70XX
D: Weld size to column (1/16 in)	:	3

Upper left brace

Gusset

General

tp: Thickness	:	1 in

Material	:	A36
LV: Length on column	:	20.881 in

Gusset-to-Brace connection

General

Brace setback	:	0.75 in
Connection type	:	Bolted
Bolts	:	1" A490 X
Hole type	:	Standard (STD)
Hole type on gusset	:	Standard (STD)
nc: Bolt columns	:	2
nr: Rows of Bolts	:	1
s: Pitch - longitudinal center-to-center spacing	:	3 in
Leh: Longitudinal distance to edge	:	1.5 in
Lev: Transverse distance to edge	:	1.5 in
End connection type	:	Slotted
Material	:	A36
Plate thickness	:	0.563 in
Weld	:	E70XX
D: Weld size (1/16 in)	:	4
Weld clearance	:	0.313 in
Weld lengh on brace	:	4 in

Gusset-to-Column connection

General

Connection type to column	:	Directly welded

Directly welded

Column weld	:	E70XX
D: Weld size to column (1/16 in)	:	3

Design code: AISC 360-16 LRFD

DEMANDS

	Right beam			Left beam			Column		
Description	**Pu** [kip]	**Vu** [kip]	**Mu33** [kip*ft]	**Pu** [kip]	**Vu** [kip]	**Mu33** [kip*ft]	**Pu** [kip]	**Vu** [kip]	**Load type**
DL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Design

	Pu				
Description	**Brace1** [kip]	**Brace2** [kip]	**Brace3** [kip]	**Brace4** [kip]	**Load type**
DL	51.78	51.78	0.00	0.00	Design

Interface between Gusset - Top right brace

Connection: Directly bolted

DEMANDS

Pu [kip]	**Description**	**Load type**
51.78	DL	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Directly bolted						
Transverse edge distance	[in]	2.56	1.25	--	✔	Tables J3.4, J3.5
Longitudinal edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
Longitudinal center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
Gusset						
Transverse edge distance	[in]	4.28	1.25	--	✔	Tables J3.4,

Longitudinal edge distance	[in]	1.50	1.25	--	✔	J3.5 Tables J3.4, J3.5
Welds						
Connector to brace weld size	[1/16in]	4	4	8	✔	table J2.4, Sec. J2.2b

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Directly bolted						
Bolts shear	[Kip]	99.44	51.78	DL	0.52	Tables (7-1..14)
Bolt bearing under shear load	[Kip]	82.58	51.78	DL	0.63	Eq. J3-6
Block shear rupture at brace web	[Kip]	88.09	51.78	DL	0.59	Eq. J4-5
Tab tensile yielding	[Kip]	63.13	51.78	DL	0.82	Eq. J4-1
Tab tensile rupture	[Kip]	55.71	51.78	DL	0.93	Eq. J4-2
Welds						
Weld capacity	[Kip]	89.10	51.78	DL	0.58	Eq. J2-4
Gusset						
Bolt bearing on gusset	[Kip]	146.81	51.78	DL	0.35	Eq. J3-6
Brace						
HSS wall shear yielding	[Kip]	102.89	51.78	DL	0.50	Eq. J4-3
HSS wall shear rupture	[Kip]	97.30	51.78	DL	0.53	Eq. J4-4
Ratio	**0.93**					

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	139.52	51.78	DL	0.37	Eq. J4-1
Tension rupture	[Kip]	83.70	51.78	DL	0.62	Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	112.24	51.78	DL	0.46	Eq. J4-1
Ratio	**0.62**					

Upper right gusset interface - column

Directly welded

DEMANDS

Description	Beam			Column			Load type
	Ru [kip]	**Pu** [kip]	**Mu** [kip*ft]	**Pu** [kip]	**Mu22** [kip*ft]	**Mu33** [kip*ft]	
DL	36.62	36.62	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	676.55	36.62	DL	0.05	Eq. B-1, Appendix B, DG29, Eq. J4-1
Shear yielding	[Kip]	451.03	36.62	DL	0.08	Eq. J4-3
Gusset edge tension stress	[Kip/in2]	32.40	1.75	DL	0.05	J4-1
Gusset edge shear stress	[Kip/in2]	21.60	1.75	DL	0.08	J4-1
Weld capacity	[Kip]	226.27	64.73	DL	0.29	Tables 8-4 .. 8-11
Column						
Chord wall plastification	[Kip]	133.11	51.78	DL	0.39	Eq. J4-5
HSS wall strength due out-of-plane transverse load	[Kip]	105.58	36.62	DL	0.35	p.9-16

Ratio	**0.39**

Interface between Gusset - Top left brace

Connection: Directly bolted

DEMANDS

Pu [kip]	Description	Load type
51.78	DL	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Directly bolted						
Transverse edge distance	[in]	2.56	1.25	--	✓	Tables J3.4, J3.5
Longitudinal edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
Longitudinal center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✓	Sec. J3.3, Sec. J3.5
Gusset						
Transverse edge distance	[in]	4.28	1.25	--	✓	Tables J3.4, J3.5
Longitudinal edge distance	[in]	1.50	1.25	--	✓	Tables J3.4, J3.5
Welds						
Connector to brace weld size	[1/16in]	4	4	8	✓	table J2.4, Sec. J2.2b

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Directly bolted						
Bolts shear	[Kip]	99.44	51.78	DL	0.52	Tables (7-1..14)
Bolt bearing under shear load	[Kip]	82.58	51.78	DL	0.63	Eq. J3-6
Block shear rupture at brace web	[Kip]	88.09	51.78	DL	0.59	Eq. J4-5
Tab tensile yielding	[Kip]	63.13	51.78	DL	0.82	Eq. J4-1
Tab tensile rupture	[Kip]	55.71	51.78	DL	0.93	Eq. J4-2
Welds						
Weld capacity	[Kip]	89.10	51.78	DL	0.58	Eq. J2-4
Gusset						
Bolt bearing on gusset	[Kip]	146.81	51.78	DL	0.35	Eq. J3-6
Brace						
HSS wall shear yielding	[Kip]	102.89	51.78	DL	0.50	Eq. J4-3
HSS wall shear rupture	[Kip]	97.30	51.78	DL	0.53	Eq. J4-4

Ratio	**0.93**

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	139.52	51.78	DL	0.37	Eq. J4-1
Tension rupture	[Kip]	83.70	51.78	DL	0.62	Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	112.24	51.78	DL	0.46	Eq. J4-1

Ratio	**0.62**

Upper left gusset interface - column
Directly welded

DEMANDS

Description	Beam **Ru** [kip]	Beam **Pu** [kip]	Beam **Mu** [kip*ft]	Column **Pu** [kip]	Column **Mu22** [kip*ft]	Column **Mu33** [kip*ft]	**Load type**
DL	36.62	36.62	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Gusset						
Beam yielding (normal stress)	[Kip]	676.55	36.62	DL	**0.05**	Eq. B-1, Appendix B, DG29, Eq. J4-1
Shear yielding	[Kip]	451.03	36.62	DL	**0.08**	Eq. J4-3
Gusset edge tension stress	[Kip/in2]	32.40	1.75	DL	**0.05**	J4-1
Gusset edge shear stress	[Kip/in2]	21.60	1.75	DL	**0.08**	J4-1
Weld capacity	[Kip]	226.27	64.73	DL	**0.29**	Tables 8-4 .. 8-11
Column						
Chord wall plastification	[Kip]	133.11	51.78	DL	**0.39**	Eq. J4-5
HSS wall strength due out-of-plane transverse load	[Kip]	105.58	36.62	DL	**0.35**	p.9-16
Ratio	**0.39**					

Global critical strength ratio **0.93**

REFERENCES

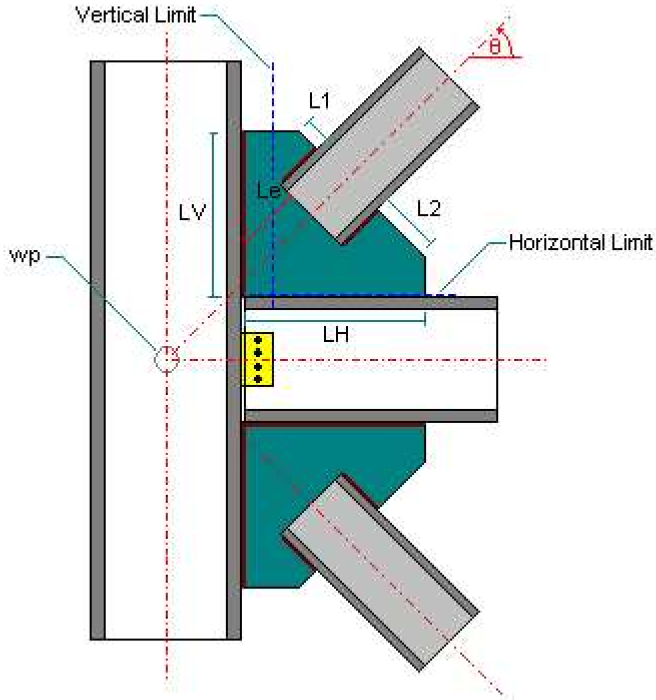
[9] AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Connection name : CBB_DW_CBF
Connection ID : 5

Family: Column - Beams - Braces (CBB)
Type: Gusset

GENERAL INFORMATION

Connector



MEMBERS

Actual members

Right beam	:	No
Left beam	:	No
Upper right brace	:	Yes
Upper left brace	:	No
Lower left brace	:	No
Lower right brace	:	No
Align beams to top edge	:	No

Column

General

Column section	:	W 21X44
Column material	:	A992 Gr50
Column orientation	:	Longitudinal
Is column end	:	No

Upper right brace

General

Section	:	HSS_SQR 4X4X1_4
Material	:	A36
Brace slope angle (degrees)	:	45
Brace long leg on gusset	:	Yes

Additional geometric data

wpx: WP horizontal displacement	:	0 in
wpy: WP vertical displacement	:	0 in
Le: Minimum distance to other members	:	2 in
L1: Left distance	:	2 in
L2: Right distance	:	2 in

INTERFACES

Upper right brace

Gusset

General

tp: Thickness	:	1 in
Material	:	A36
LV: Length on column	:	20.881 in

Gusset-to-Brace connection

General

Brace setback	:	0.75 in
Connection type	:	Bolted
Bolts	:	1" A490 X
Hole type	:	Standard (STD)
Hole type on gusset	:	Standard (STD)
nc: Bolt columns	:	2
nr: Rows of Bolts	:	1
s: Pitch - longitudinal center-to-center spacing	:	3 in
Leh: Longitudinal distance to edge	:	1.5 in
Lev: Transverse distance to edge	:	1.5 in
End connection type	:	Slotted
Material	:	A36
Plate thickness	:	0.563 in
Weld	:	E70XX
Weld size to brace (1/16 in)	:	4
Weld clearance	:	0.313 in
Weld lengh on brace	:	4 in

Gusset-to-Column connection

General

Connection type to column	:	Directly welded

Directly welded

Column weld	:	E70XX
D: Weld size to column (1/16 in)	:	3

Design code: AISC 360-16 LRFD

DEMANDS

	Right beam			Left beam			Column		
Description	**Pu** [kip]	**Vu** [kip]	**Mu33** [kip*ft]	**Pu** [kip]	**Vu** [kip]	**Mu33** [kip*ft]	**Pu** [kip]	**Vu** [kip]	**Load type**
DL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.65	Design

	Pu				
Description	**Brace1** [kip]	**Brace2** [kip]	**Brace3** [kip]	**Brace4** [kip]	**Load type**
DL	51.78	0.00	0.00	0.00	Design

Interface between Gusset - Top right brace

Connection: Directly bolted

DEMANDS

Pu [kip]	**Description**	**Load type**
51.78	DL	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Directly bolted						
Transverse edge distance	[in]	2.56	1.25	--	✔	Tables J3.4, J3.5
Longitudinal edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
Longitudinal center-to-center spacing (pitch)	[in]	3.00	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
Gusset						
Transverse edge distance	[in]	4.28	1.25	--	✔	Tables J3.4, J3.5
Longitudinal edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5

Welds						
Connector to brace weld size	[1/16in]	4	4	8	✔	table J2.4, Sec. J2.2b

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Directly bolted						
Bolts shear	[Kip]	99.44	51.78	DL	**0.52**	Tables (7-1..14)
Bolt bearing under shear load	[Kip]	82.58	51.78	DL	**0.63**	Eq. J3-6
Block shear rupture at brace web	[Kip]	88.09	51.78	DL	**0.59**	Eq. J4-5
Tab tensile yielding	[Kip]	63.13	51.78	DL	**0.82**	Eq. J4-1
Tab tensile rupture	[Kip]	55.71	51.78	DL	**0.93**	Eq. J4-2
Welds						
Weld capacity	[Kip]	89.10	51.78	DL	**0.58**	Eq. J2-4
Gusset						
Bolt bearing on gusset	[Kip]	146.81	51.78	DL	**0.35**	Eq. J3-6
Brace						
HSS wall shear yielding	[Kip]	80.52	51.78	DL	**0.64**	Eq. J4-3
HSS wall shear rupture	[Kip]	97.30	51.78	DL	**0.53**	Eq. J4-4
Ratio	**0.93**					

Checks for gusset and brace

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Brace						
Yielding strength due to axial load	[Kip]	109.19	51.78	DL	**0.47**	Eq. J4-1
Tension rupture	[Kip]	83.70	51.78	DL	**0.62**	Eq. J4-2
Gusset						
Tension yielding on the Whitmore section	[Kip]	112.24	51.78	DL	**0.46**	Eq. J4-1
Ratio	**0.62**					

Upper right gusset interface - column

Directly welded

DEMANDS

	Beam			Column			
Description	**Ru** [kip]	**Pu** [kip]	**Mu** [kip*ft]	**Pu** [kip]	**Mu22** [kip*ft]	**Mu33** [kip*ft]	**Load type**
DL	36.62	36.62	0.00	0.00	0.00	0.00	Design

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Gusset						
Beam yielding (normal stress)	[Kip]	676.55	36.62	DL	**0.05**	Eq. B-1, Appendix B, DG29, Eq. J4-1
Shear yielding	[Kip]	451.03	36.62	DL	**0.08**	Eq. J4-3
Gusset edge tension stress	[Kip/in2]	32.40	1.75	DL	**0.05**	J4-1
Gusset edge shear stress	[Kip/in2]	21.60	1.75	DL	**0.08**	J4-1
Weld capacity	[Kip]	226.27	64.73	DL	**0.29**	Tables 8-4 .. 8-11
Column						
Web crippling	[Kip]	308.68	36.62	DL	**0.12**	Eq. J10-4, Eq. B-1, Appendix B, DG29
Local web yielding	[Kip]	448.54	36.62	DL	**0.08**	Eq. J10-2, Eq. B-1,

Ratio	**0.29**
Global critical strength ratio	**0.93**

REFERENCES

[9] AISC 2005, Design Examples Version 13.0, pp. IIC-26 - IIC-27

Hangar Member Results and Connection Design

Nodal loads and displacements, distributed loads, material take off, member internal forces results, and connection design results are shown in the following documents.

Combined K, VS, LH & DLH Series Load Table

29' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
16K3	193	106	5.9
18K3	218	136	6.2
16K4	232	124	6.7
20K3	243	170	6.6
18K4	263	159	7.0
20K4	293	199	7.4
18K5	296	179	7.7
22K4	324	242	7.8
20K5	330	223	8.1
22K5	365	272	8.7
26K5	434	384	8.0
24K6	435	354	8.4
28K6	511	486	9.1
28K7	550	522	9.5
18LH5	581	345	14
20LH5	595	395	13
18LH6	648	377	15
24LH6	708	567	14
24LH7	778	623	15
20LH7	786	518	16
24LH8	830	662	16
24LH9	977	775	18
24LH10	1033	822	19
24LH11	1088	861	20

30' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
18K3	203	123	6.1
16K4	216	112	6.6
20K3	227	153	6.5
18K4	245	144	6.9
20K4	274	179	7.3
18K5	276	161	7.7
20K5	308	201	8.0
20K6	336	218	8.7
22K6	371	266	8.2
26K5	405	346	8.0
24K6	406	319	8.4
26K6	441	377	8.8
28K6	477	439	9.0
26K7	492	417	9.2
28K7	531	486	9.5
26K8	544	457	10
26K9	550	459	10
20LH5	571	366	13
18LH6	605	340	15
24LH6	684	529	14
24LH7	752	582	15
24LH8	802	618	16
24LH9	944	724	18
24LH10	998	768	19
24LH11	1052	804	21

31' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
16K4	203	101	6.6
20K3	212	138	6.6
18K4	229	130	6.9
20K4	256	162	7.4
18K5	258	146	7.7
22K4	283	198	7.8
20K5	289	182	8.1
24K4	310	237	8.4
20K6	314	198	8.8
22K5	319	222	8.7
22K6	347	241	8.3
26K5	379	314	8.1
24K6	380	289	8.6
22K7	387	267	8.8
28K6	446	397	9.0
22K9	465	316	10
28K8	550	480	10
24LH6	662	495	14

31' LENGTH (Cont.)

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
24LH7	727	545	15
24LH8	776	579	16
24LH9	913	677	19
24LH10	965	718	20
24LH11	1017	752	21

32' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
16K2	142	71	5.5
16K3	158	79	5.8
18K3	178	101	6.1
20K4	240	147	7.2
18K5	242	132	7.6
20K5	271	165	7.9
24K4	290	215	8.1
22K5	299	201	8.4
22K6	326	219	8.4
26K5	356	285	8.0
24K6	357	262	8.5
26K6	387	309	8.6
28K6	418	361	8.9
22K9	436	287	10
28K7	466	400	9.5
26K8	477	375	9.9
28K8	515	433	10
28K9	549	463	11
24LH6	641	465	14
24LH7	704	511	15
24LH8	752	543	16
24LH9	884	635	19
24LH10	935	674	20
24LH11	985	705	20

33' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
18K3	168	92	6.1
20K4	226	134	7.3
22K4	249	164	7.9
20K5	254	150	8.1
24K4	273	196	8.3
20K6	277	163	8.7
22K5	281	183	8.5
26K5	334	259	8.0
24K6	335	239	8.3
26K6	364	282	8.6
28K6	393	329	8.8
26K7	406	312	9.1
28K7	438	364	9.4
28K8	484	399	10
26K9	488	370	11
28K9	527	432	11
28K10	532	435	11
24LH6	621	437	15
24LH7	683	480	16
24LH8	729	510	16
24LH9	857	597	19
24LH10	906	633	20
24LH11	955	663	22

34' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
18K3	158	84	6.1
20K3	176	105	6.4
18K4	190	98	6.9
18K6	233	120	8.2
24K4	257	179	8.1
20K6	261	149	8.6
22K5	265	167	8.4
26K5	315	237	7.9
26K6	343	257	8.5
28K6	370	300	8.8
26K7	382	285	9.1
28K7	412	333	9.4

34' LENGTH (Cont.)

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
24K9	423	286	10
28K8	456	364	10
28K9	496	395	11
28K10	516	410	11
28LH6	552	443	13
28LH7	624	499	14
28LH8	668	533	15
24LH8	707	480	17
28LH9	823	656	17
24LH9	832	562	20
28LH10	900	714	19
28LH11	965	763	20
28LH12	1060	835	23
28LH13	1105	872	23

35' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
18K3	149	77	6.1
20K3	166	96	6.5
18K4	179	90	6.9
20K4	200	112	7.3
20K6	246	137	8.7
26K5	297	217	7.9
26K6	323	236	8.5
28K6	349	275	8.7
26K7	360	261	9.0
28K7	389	305	9.4
28K8	430	333	9.9
26K9	433	310	10
28K9	468	361	11
28K10	501	389	11
28LH6	537	417	13
28LH7	606	471	14
28LH8	649	503	15
24LH8	677	447	17
28LH9	799	618	18
28LH10	874	673	20
28LH11	938	719	21
28LH12	1030	787	23
28LH13	1073	822	24

36' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
18K3	141	70	6.1
20K3	157	88	6.4
18K4	169	82	6.9
20K4	189	103	7.2
18K5	191	92	7.5
24K6	281	183	8.3
22K7	286	169	8.7
24K7	313	203	8.8
28K6	330	252	8.8
26K7	340	240	9.1
24K8	346	222	9.5
28K7	367	280	9.4
26K8	376	263	9.8
30K7	395	323	9.6
28K9	442	332	11
28K10	487	366	12
28LH6	521	394	13
28LH7	589	445	14
28LH8	631	475	15
24LH8	649	416	17
28LH9	777	584	18
28LH10	850	636	19
28LH11	911	680	21
28LH12	1001	744	23
28LH13	1043	777	24

37' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
20K3	148	81	6.4
20K4	179	95	7.3

37' LENGTH (Cont.)

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
26K5	265	183	7.9
24K6	266	169	8.3
28K6	312	232	8.7
26K7	322	221	9.1
28K7	348	257	9.3
30K7	373	297	9.5
28K8	384	282	9.9
26K9	387	262	10
30K8	413	325	10
28K9	418	305	11
30K9	449	352	11
30K10	474	374	12
28LH6	507	373	13
24LH6	530	331	15
28LH7	573	421	15
24LH7	588	367	16
28LH8	614	449	16
24LH8	622	388	17
28LH9	755	553	18
28LH10	826	602	21
28LH11	886	643	21
28LH12	974	704	23
28LH13	1015	735	25

38' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
20K3	141	74	6.3
20K4	170	87	7.2
24K6	252	156	8.3
28K6	296	214	8.6
26K7	305	204	9.0
28K7	329	237	9.2
30K7	354	274	9.5
28K8	364	260	9.9
26K9	367	241	10
30K8	391	300	10
28K9	396	282	11
30K9	426	325	11
30K10	461	353	11
28LH6	494	354	13
24LH6	504	306	15
28LH7	558	399	15
24LH7	565	343	16
28LH8	597	426	16
28LH9	735	524	19
28LH10	804	570	20
28LH11	863	609	22
28LH12	948	667	23
28LH13	988	696	26

39' LENGTH

Joist Type	Allowable Loads (PLF) Total	Uniform	Joist Weight (lbs./ft.)
20K3	133	69	6.4
20K4	161	81	7.3
20K5	181	90	7.9
28K6	280	198	8.6
26K7	289	188	9.0
28K7	313	219	9.1
30K7	336	253	9.5
28K8	346	240	9.9
26K9	348	223	10
30K8	371	277	10
28K9	376	260	11
30K9	404	300	11
26K10	413	262	12
30K10	449	333	12
32LH7	486	388	13
32LH8	528	421	14
28LH7	543	379	15
32LH9	662	526	17
32LH10	732	581	18
32LH11	802	635	20
28LH11	841	578	22

Node Loads and Enforced Displacements (BLC 15 : ELX)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N103	L	X	106.55	Active

Node Loads and Enforced Displacements (BLC 16 : ELZ)

	Node Label	L, D, M	Direction	Magnitude [(k, k-ft), (…	Inactive [(k, k-ft), (in,…
1	N103	L	Z	106.55	Active

Member Distributed Loads (BLC 1 : DL)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1	M54	Y	-0.38	-0.38	0	%100	Active
2	M55	Y	-0.38	-0.38	0	%100	Active
3	M57	Y	-0.38	-0.38	0	%100	Active
4	M58	Y	-0.38	-0.38	0	%100	Active
5	M60	Y	-0.38	-0.38	0	%100	Active
6	M63	Y	-0.38	-0.38	0	%100	Active
7	M64	Y	-0.38	-0.38	0	%100	Active
8	M66	Y	-0.38	-0.38	0	%100	Active
9	M67	Y	-0.38	-0.38	0	%100	Active
10	M69	Y	-0.38	-0.38	0	%100	Active
11	M70	Y	-0.38	-0.38	0	%100	Active
12	M72	Y	-0.38	-0.38	0	%100	Active
13	M73	Y	-0.38	-0.38	0	%100	Active
14	M75	Y	-0.38	-0.38	0	%100	Active
15	M76	Y	-0.38	-0.38	0	%100	Active
16	M78	Y	-0.38	-0.38	0	%100	Active
17	M79	Y	-0.38	-0.38	0	%100	Active
18	M81	Y	-0.38	-0.38	0	%100	Active
19	M82	Y	-0.38	-0.38	0	%100	Active
20	M84	Y	-0.38	-0.38	0	%100	Active
21	M85	Y	-0.38	-0.38	0	%100	Active
22	M87	Y	-0.38	-0.38	0	%100	Active
23	M88	Y	-0.38	-0.38	0	%100	Active
24	M90	Y	-0.38	-0.38	0	%100	Active
25	M91	Y	-0.38	-0.38	0	%100	Active
26	M93	Y	-0.38	-0.38	0	%100	Active
27	M94	Y	-0.38	-0.38	0	%100	Active
28	M96	Y	-0.38	-0.38	0	%100	Active
29	M97	Y	-0.38	-0.38	0	%100	Active
30	M99	Y	-0.38	-0.38	0	%100	Active
31	M100	Y	-0.38	-0.38	0	%100	Active
32	M101	Y	-0.38	-0.38	0	%100	Active
33	M97	Y	-0.08	-0.08	0	%100	Active
34	M100	Y	-0.08	-0.08	0	%100	Active
35	M94	Y	-0.08	-0.08	0	%100	Active
36	M91	Y	-0.08	-0.08	0	%100	Active
37	M85	Y	-0.08	-0.08	0	%100	Active
38	M88	Y	-0.08	-0.08	0	%100	Active
39	M82	Y	-0.08	-0.08	0	%100	Active
40	M79	Y	-0.08	-0.08	0	%100	Active
41	M73	Y	-0.08	-0.08	0	%100	Active
42	M76	Y	-0.08	-0.08	0	%100	Active
43	M70	Y	-0.08	-0.08	0	%100	Active
44	M67	Y	-0.08	-0.08	0	%100	Active
45	M60	Y	-0.08	-0.08	0	%100	Active
46	M64	Y	-0.08	-0.08	0	%100	Active
47	M58	Y	-0.08	-0.08	0	%100	Active
48	M54	Y	-0.08	-0.08	0	%100	Active

Member Distributed Loads (BLC 4 : RLL)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1	M54	Y	-0.38	-0.38	0	%100	Active
2	M55	Y	-0.38	-0.38	0	%100	Active
3	M57	Y	-0.38	-0.38	0	%100	Active
4	M58	Y	-0.38	-0.38	0	%100	Active
5	M60	Y	-0.38	-0.38	0	%100	Active
6	M63	Y	-0.38	-0.38	0	%100	Active
7	M64	Y	-0.38	-0.38	0	%100	Active
8	M66	Y	-0.38	-0.38	0	%100	Active
9	M67	Y	-0.38	-0.38	0	%100	Active
10	M69	Y	-0.38	-0.38	0	%100	Active
11	M70	Y	-0.38	-0.38	0	%100	Active
12	M72	Y	-0.38	-0.38	0	%100	Active
13	M73	Y	-0.38	-0.38	0	%100	Active
14	M75	Y	-0.38	-0.38	0	%100	Active
15	M76	Y	-0.38	-0.38	0	%100	Active
16	M78	Y	-0.38	-0.38	0	%100	Active
17	M79	Y	-0.38	-0.38	0	%100	Active
18	M81	Y	-0.38	-0.38	0	%100	Active
19	M82	Y	-0.38	-0.38	0	%100	Active
20	M84	Y	-0.38	-0.38	0	%100	Active
21	M85	Y	-0.38	-0.38	0	%100	Active
22	M87	Y	-0.38	-0.38	0	%100	Active
23	M88	Y	-0.38	-0.38	0	%100	Active
24	M90	Y	-0.38	-0.38	0	%100	Active
25	M91	Y	-0.38	-0.38	0	%100	Active
26	M93	Y	-0.38	-0.38	0	%100	Active
27	M94	Y	-0.38	-0.38	0	%100	Active
28	M96	Y	-0.38	-0.38	0	%100	Active
29	M97	Y	-0.38	-0.38	0	%100	Active
30	M99	Y	-0.38	-0.38	0	%100	Active
31	M100	Y	-0.38	-0.38	0	%100	Active
32	M101	Y	-0.38	-0.38	0	%100	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1	M3	X	-0.086	-0.081	2.22e-15	1	Active
2	M3	X	-0.081	-0.075	1	2	Active
3	M3	X	-0.075	-0.07	2	3	Active
4	M3	X	-0.07	-0.064	3	4	Active
5	M3	X	-0.064	-0.058	4	5	Active
6	M3	X	-0.058	-0.053	5	6	Active
7	M3	X	-0.053	-0.047	6	7	Active
8	M3	X	-0.047	-0.042	7	8	Active
9	M3	X	-0.042	-0.036	8	9	Active
10	M3	X	-0.036	-0.031	9	10	Active
11	M3	X	-0.031	-0.025	10	11	Active
12	M3	X	-0.025	-0.019	11	12	Active
13	M3	X	-0.019	-0.014	12	13	Active
14	M3	X	-0.014	-0.008	13	14	Active
15	M3	X	-0.008	-0.003	14	15	Active
16	M29	X	-0.175	-0.164	3.78e-14	1	Active
17	M29	X	-0.164	-0.153	1	2	Active
18	M29	X	-0.153	-0.143	2	3	Active
19	M29	X	-0.143	-0.132	3	4	Active
20	M29	X	-0.132	-0.121	4	5	Active
21	M29	X	-0.121	-0.11	5	6	Active
22	M29	X	-0.11	-0.099	6	7	Active
23	M29	X	-0.099	-0.088	7	8	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
24	M29	X	-0.088	-0.077	8	9	Active
25	M29	X	-0.077	-0.066	9	10	Active
26	M29	X	-0.066	-0.055	10	11	Active
27	M29	X	-0.055	-0.044	11	12	Active
28	M29	X	-0.044	-0.033	12	13	Active
29	M29	X	-0.033	-0.022	13	14	Active
30	M29	X	-0.022	-0.011	14	15	Active
31	M29	X	-0.011	8.437e-05	15	16	Active
32	M30	X	-0.154	-0.149	4.441e-16	1	Active
33	M30	X	-0.149	-0.143	1	2	Active
34	M30	X	-0.143	-0.138	2	3	Active
35	M30	X	-0.138	-0.132	3	4	Active
36	M30	X	-0.132	-0.124	4	5	Active
37	M30	X	-0.124	-0.113	5	6	Active
38	M30	X	-0.113	-0.103	6	7	Active
39	M30	X	-0.103	-0.092	7	8	Active
40	M30	X	-0.092	-0.081	8	9	Active
41	M30	X	-0.081	-0.07	9	10	Active
42	M30	X	-0.07	-0.059	10	11	Active
43	M30	X	-0.059	-0.049	11	12	Active
44	M30	X	-0.049	-0.038	12	13	Active
45	M30	X	-0.038	-0.027	13	14	Active
46	M30	X	-0.027	-0.016	14	15	Active
47	M30	X	-0.016	-0.005	15	16	Active
48	M31	X	-0.154	-0.149	1.221e-15	1	Active
49	M31	X	-0.149	-0.143	1	2	Active
50	M31	X	-0.143	-0.138	2	3	Active
51	M31	X	-0.138	-0.132	3	4	Active
52	M31	X	-0.132	-0.124	4	5	Active
53	M31	X	-0.124	-0.113	5	6	Active
54	M31	X	-0.113	-0.103	6	7	Active
55	M31	X	-0.103	-0.092	7	8	Active
56	M31	X	-0.092	-0.081	8	9	Active
57	M31	X	-0.081	-0.07	9	10	Active
58	M31	X	-0.07	-0.059	10	11	Active
59	M31	X	-0.059	-0.049	11	12	Active
60	M31	X	-0.049	-0.038	12	13	Active
61	M31	X	-0.038	-0.027	13	14	Active
62	M31	X	-0.027	-0.016	14	15	Active
63	M31	X	-0.016	-0.005	15	16	Active
64	M32	X	-0.154	-0.149	4.441e-16	1	Active
65	M32	X	-0.149	-0.143	1	2	Active
66	M32	X	-0.143	-0.138	2	3	Active
67	M32	X	-0.138	-0.132	3	4	Active
68	M32	X	-0.132	-0.124	4	5	Active
69	M32	X	-0.124	-0.113	5	6	Active
70	M32	X	-0.113	-0.103	6	7	Active
71	M32	X	-0.103	-0.092	7	8	Active
72	M32	X	-0.092	-0.081	8	9	Active
73	M32	X	-0.081	-0.07	9	10	Active
74	M32	X	-0.07	-0.059	10	11	Active
75	M32	X	-0.059	-0.049	11	12	Active
76	M32	X	-0.049	-0.038	12	13	Active
77	M32	X	-0.038	-0.027	13	14	Active
78	M32	X	-0.027	-0.016	14	15	Active
79	M32	X	-0.016	-0.005	15	16	Active
80	M33	X	-0.154	-0.149	1.221e-15	1	Active
81	M33	X	-0.149	-0.143	1	2	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
82	M33	X	-0.143	-0.138	2	3	Active
83	M33	X	-0.138	-0.132	3	4	Active
84	M33	X	-0.132	-0.124	4	5	Active
85	M33	X	-0.124	-0.113	5	6	Active
86	M33	X	-0.113	-0.103	6	7	Active
87	M33	X	-0.103	-0.092	7	8	Active
88	M33	X	-0.092	-0.081	8	9	Active
89	M33	X	-0.081	-0.07	9	10	Active
90	M33	X	-0.07	-0.059	10	11	Active
91	M33	X	-0.059	-0.049	11	12	Active
92	M33	X	-0.049	-0.038	12	13	Active
93	M33	X	-0.038	-0.027	13	14	Active
94	M33	X	-0.027	-0.016	14	15	Active
95	M33	X	-0.016	-0.005	15	16	Active
96	M34	X	-0.154	-0.149	4.441e-16	1	Active
97	M34	X	-0.149	-0.143	1	2	Active
98	M34	X	-0.143	-0.138	2	3	Active
99	M34	X	-0.138	-0.132	3	4	Active
100	M34	X	-0.132	-0.124	4	5	Active
101	M34	X	-0.124	-0.113	5	6	Active
102	M34	X	-0.113	-0.103	6	7	Active
103	M34	X	-0.103	-0.092	7	8	Active
104	M34	X	-0.092	-0.081	8	9	Active
105	M34	X	-0.081	-0.07	9	10	Active
106	M34	X	-0.07	-0.059	10	11	Active
107	M34	X	-0.059	-0.049	11	12	Active
108	M34	X	-0.049	-0.038	12	13	Active
109	M34	X	-0.038	-0.027	13	14	Active
110	M34	X	-0.027	-0.016	14	15	Active
111	M34	X	-0.016	-0.005	15	16	Active
112	M35	X	-0.154	-0.149	1.221e-15	1	Active
113	M35	X	-0.149	-0.143	1	2	Active
114	M35	X	-0.143	-0.138	2	3	Active
115	M35	X	-0.138	-0.132	3	4	Active
116	M35	X	-0.132	-0.124	4	5	Active
117	M35	X	-0.124	-0.113	5	6	Active
118	M35	X	-0.113	-0.103	6	7	Active
119	M35	X	-0.103	-0.092	7	8	Active
120	M35	X	-0.092	-0.081	8	9	Active
121	M35	X	-0.081	-0.07	9	10	Active
122	M35	X	-0.07	-0.059	10	11	Active
123	M35	X	-0.059	-0.049	11	12	Active
124	M35	X	-0.049	-0.038	12	13	Active
125	M35	X	-0.038	-0.027	13	14	Active
126	M35	X	-0.027	-0.016	14	15	Active
127	M35	X	-0.016	-0.005	15	16	Active
128	M36	X	-0.154	-0.149	4.441e-16	1	Active
129	M36	X	-0.149	-0.143	1	2	Active
130	M36	X	-0.143	-0.138	2	3	Active
131	M36	X	-0.138	-0.132	3	4	Active
132	M36	X	-0.132	-0.124	4	5	Active
133	M36	X	-0.124	-0.113	5	6	Active
134	M36	X	-0.113	-0.103	6	7	Active
135	M36	X	-0.103	-0.092	7	8	Active
136	M36	X	-0.092	-0.081	8	9	Active
137	M36	X	-0.081	-0.07	9	10	Active
138	M36	X	-0.07	-0.059	10	11	Active
139	M36	X	-0.059	-0.049	11	12	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
140	M36	X	-0.049	-0.038	12	13	Active
141	M36	X	-0.038	-0.027	13	14	Active
142	M36	X	-0.027	-0.016	14	15	Active
143	M36	X	-0.016	-0.005	15	16	Active
144	M37	X	-0.154	-0.149	1.221e-15	1	Active
145	M37	X	-0.149	-0.143	1	2	Active
146	M37	X	-0.143	-0.138	2	3	Active
147	M37	X	-0.138	-0.132	3	4	Active
148	M37	X	-0.132	-0.124	4	5	Active
149	M37	X	-0.124	-0.113	5	6	Active
150	M37	X	-0.113	-0.103	6	7	Active
151	M37	X	-0.103	-0.092	7	8	Active
152	M37	X	-0.092	-0.081	8	9	Active
153	M37	X	-0.081	-0.07	9	10	Active
154	M37	X	-0.07	-0.059	10	11	Active
155	M37	X	-0.059	-0.049	11	12	Active
156	M37	X	-0.049	-0.038	12	13	Active
157	M37	X	-0.038	-0.027	13	14	Active
158	M37	X	-0.027	-0.016	14	15	Active
159	M37	X	-0.016	-0.005	15	16	Active
160	M38	X	-0.154	-0.149	4.441e-16	1	Active
161	M38	X	-0.149	-0.143	1	2	Active
162	M38	X	-0.143	-0.138	2	3	Active
163	M38	X	-0.138	-0.132	3	4	Active
164	M38	X	-0.132	-0.124	4	5	Active
165	M38	X	-0.124	-0.113	5	6	Active
166	M38	X	-0.113	-0.103	6	7	Active
167	M38	X	-0.103	-0.092	7	8	Active
168	M38	X	-0.092	-0.081	8	9	Active
169	M38	X	-0.081	-0.07	9	10	Active
170	M38	X	-0.07	-0.059	10	11	Active
171	M38	X	-0.059	-0.049	11	12	Active
172	M38	X	-0.049	-0.038	12	13	Active
173	M38	X	-0.038	-0.027	13	14	Active
174	M38	X	-0.027	-0.016	14	15	Active
175	M38	X	-0.016	-0.005	15	16	Active
176	M39	X	-0.154	-0.149	1.221e-15	1	Active
177	M39	X	-0.149	-0.143	1	2	Active
178	M39	X	-0.143	-0.138	2	3	Active
179	M39	X	-0.138	-0.132	3	4	Active
180	M39	X	-0.132	-0.124	4	5	Active
181	M39	X	-0.124	-0.113	5	6	Active
182	M39	X	-0.113	-0.103	6	7	Active
183	M39	X	-0.103	-0.092	7	8	Active
184	M39	X	-0.092	-0.081	8	9	Active
185	M39	X	-0.081	-0.07	9	10	Active
186	M39	X	-0.07	-0.059	10	11	Active
187	M39	X	-0.059	-0.049	11	12	Active
188	M39	X	-0.049	-0.038	12	13	Active
189	M39	X	-0.038	-0.027	13	14	Active
190	M39	X	-0.027	-0.016	14	15	Active
191	M39	X	-0.016	-0.005	15	16	Active
192	M40	X	-0.154	-0.149	4.441e-16	1	Active
193	M40	X	-0.149	-0.143	1	2	Active
194	M40	X	-0.143	-0.138	2	3	Active
195	M40	X	-0.138	-0.132	3	4	Active
196	M40	X	-0.132	-0.124	4	5	Active
197	M40	X	-0.124	-0.113	5	6	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
198	M40	X	-0.113	-0.103	6	7	Active
199	M40	X	-0.103	-0.092	7	8	Active
200	M40	X	-0.092	-0.081	8	9	Active
201	M40	X	-0.081	-0.07	9	10	Active
202	M40	X	-0.07	-0.059	10	11	Active
203	M40	X	-0.059	-0.049	11	12	Active
204	M40	X	-0.049	-0.038	12	13	Active
205	M40	X	-0.038	-0.027	13	14	Active
206	M40	X	-0.027	-0.016	14	15	Active
207	M40	X	-0.016	-0.005	15	16	Active
208	M41	X	-0.154	-0.149	1.221e-15	1	Active
209	M41	X	-0.149	-0.143	1	2	Active
210	M41	X	-0.143	-0.138	2	3	Active
211	M41	X	-0.138	-0.132	3	4	Active
212	M41	X	-0.132	-0.124	4	5	Active
213	M41	X	-0.124	-0.113	5	6	Active
214	M41	X	-0.113	-0.103	6	7	Active
215	M41	X	-0.103	-0.092	7	8	Active
216	M41	X	-0.092	-0.081	8	9	Active
217	M41	X	-0.081	-0.07	9	10	Active
218	M41	X	-0.07	-0.059	10	11	Active
219	M41	X	-0.059	-0.049	11	12	Active
220	M41	X	-0.049	-0.038	12	13	Active
221	M41	X	-0.038	-0.027	13	14	Active
222	M41	X	-0.027	-0.016	14	15	Active
223	M41	X	-0.016	-0.005	15	16	Active
224	M42	X	-0.154	-0.149	4.441e-16	1	Active
225	M42	X	-0.149	-0.143	1	2	Active
226	M42	X	-0.143	-0.138	2	3	Active
227	M42	X	-0.138	-0.132	3	4	Active
228	M42	X	-0.132	-0.124	4	5	Active
229	M42	X	-0.124	-0.113	5	6	Active
230	M42	X	-0.113	-0.103	6	7	Active
231	M42	X	-0.103	-0.092	7	8	Active
232	M42	X	-0.092	-0.081	8	9	Active
233	M42	X	-0.081	-0.07	9	10	Active
234	M42	X	-0.07	-0.059	10	11	Active
235	M42	X	-0.059	-0.049	11	12	Active
236	M42	X	-0.049	-0.038	12	13	Active
237	M42	X	-0.038	-0.027	13	14	Active
238	M42	X	-0.027	-0.016	14	15	Active
239	M42	X	-0.016	-0.005	15	16	Active
240	M43	X	-0.154	-0.149	1.776e-15	1	Active
241	M43	X	-0.149	-0.143	1	2	Active
242	M43	X	-0.143	-0.138	2	3	Active
243	M43	X	-0.138	-0.132	3	4	Active
244	M43	X	-0.132	-0.124	4	5	Active
245	M43	X	-0.124	-0.113	5	6	Active
246	M43	X	-0.113	-0.103	6	7	Active
247	M43	X	-0.103	-0.092	7	8	Active
248	M43	X	-0.092	-0.081	8	9	Active
249	M43	X	-0.081	-0.07	9	10	Active
250	M43	X	-0.07	-0.059	10	11	Active
251	M43	X	-0.059	-0.049	11	12	Active
252	M43	X	-0.049	-0.038	12	13	Active
253	M43	X	-0.038	-0.027	13	14	Active
254	M43	X	-0.027	-0.016	14	15	Active
255	M43	X	-0.016	-0.005	15	16	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
256	M44	X	-0.089	-0.084	0	1	Active
257	M44	X	-0.084	-0.078	1	2	Active
258	M44	X	-0.078	-0.073	2	3	Active
259	M44	X	-0.073	-0.068	3	4	Active
260	M44	X	-0.068	-0.062	4	5	Active
261	M44	X	-0.062	-0.057	5	6	Active
262	M44	X	-0.057	-0.051	6	7	Active
263	M44	X	-0.051	-0.046	7	8	Active
264	M44	X	-0.046	-0.041	8	9	Active
265	M44	X	-0.041	-0.035	9	10	Active
266	M44	X	-0.035	-0.03	10	11	Active
267	M44	X	-0.03	-0.024	11	12	Active
268	M44	X	-0.024	-0.019	12	13	Active
269	M44	X	-0.019	-0.014	13	14	Active
270	M44	X	-0.014	-0.008	14	15	Active
271	M44	X	-0.008	-0.003	15	16	Active
272	M55	X	-0.003	-0.008	1.665e-15	1.031	Active
273	M55	X	-0.008	-0.014	1.031	2.063	Active
274	M55	X	-0.014	-0.019	2.063	3.094	Active
275	M55	X	-0.019	-0.024	3.094	4.125	Active
276	M55	X	-0.024	-0.03	4.125	5.156	Active
277	M55	X	-0.03	-0.035	5.156	6.188	Active
278	M55	X	-0.035	-0.041	6.188	7.219	Active
279	M55	X	-0.041	-0.046	7.219	8.25	Active
280	M55	X	-0.046	-0.051	8.25	9.281	Active
281	M55	X	-0.051	-0.057	9.281	10.313	Active
282	M55	X	-0.057	-0.062	10.313	11.344	Active
283	M55	X	-0.062	-0.068	11.344	12.375	Active
284	M55	X	-0.068	-0.073	12.375	13.406	Active
285	M55	X	-0.073	-0.078	13.406	14.438	Active
286	M55	X	-0.078	-0.084	14.438	15.469	Active
287	M55	X	-0.084	-0.086	15.469	16.5	Active
288	M55	X	-0.086	-0.084	16.5	17.531	Active
289	M55	X	-0.084	-0.078	17.531	18.563	Active
290	M55	X	-0.078	-0.073	18.563	19.594	Active
291	M55	X	-0.073	-0.068	19.594	20.625	Active
292	M55	X	-0.068	-0.062	20.625	21.656	Active
293	M55	X	-0.062	-0.057	21.656	22.688	Active
294	M55	X	-0.057	-0.051	22.688	23.719	Active
295	M55	X	-0.051	-0.046	23.719	24.75	Active
296	M55	X	-0.046	-0.041	24.75	25.781	Active
297	M55	X	-0.041	-0.035	25.781	26.813	Active
298	M55	X	-0.035	-0.03	26.813	27.844	Active
299	M55	X	-0.03	-0.024	27.844	28.875	Active
300	M55	X	-0.024	-0.019	28.875	29.906	Active
301	M55	X	-0.019	-0.014	29.906	30.938	Active
302	M55	X	-0.014	-0.008	30.938	31.969	Active
303	M55	X	-0.008	-0.003	31.969	33	Active
304	M58	X	-0.003	-0.008	1	2	Active
305	M58	X	-0.008	-0.014	2	3	Active
306	M58	X	-0.014	-0.019	3	4	Active
307	M58	X	-0.019	-0.024	4	5	Active
308	M58	X	-0.024	-0.03	5	6	Active
309	M58	X	-0.03	-0.035	6	7	Active
310	M58	X	-0.035	-0.041	7	8	Active
311	M58	X	-0.041	-0.046	8	9	Active
312	M58	X	-0.046	-0.051	9	10	Active
313	M58	X	-0.051	-0.057	10	11	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
314	M58	X	-0.057	-0.062	11	12	Active
315	M58	X	-0.062	-0.068	12	13	Active
316	M58	X	-0.068	-0.073	13	14	Active
317	M58	X	-0.073	-0.078	14	15	Active
318	M58	X	-0.078	-0.084	15	16	Active
319	M58	X	-0.084	-0.086	16	17	Active
320	M58	X	-0.086	-0.086	17	18	Active
321	M58	X	-0.086	-0.086	18	19	Active
322	M58	X	-0.086	-0.086	19	20	Active
323	M58	X	-0.086	-0.086	20	21	Active
324	M58	X	-0.086	-0.086	21	22	Active
325	M58	X	-0.086	-0.086	22	23	Active
326	M58	X	-0.086	-0.086	23	24	Active
327	M58	X	-0.086	-0.086	24	25	Active
328	M58	X	-0.086	-0.084	25	26	Active
329	M58	X	-0.084	-0.078	26	27	Active
330	M58	X	-0.078	-0.073	27	28	Active
331	M58	X	-0.073	-0.068	28	29	Active
332	M58	X	-0.068	-0.062	29	30	Active
333	M58	X	-0.062	-0.057	30	31	Active
334	M58	X	-0.057	-0.051	31	32	Active
335	M58	X	-0.051	-0.046	32	33	Active
336	M58	X	-0.046	-0.041	33	34	Active
337	M58	X	-0.041	-0.035	34	35	Active
338	M58	X	-0.035	-0.03	35	36	Active
339	M58	X	-0.03	-0.024	36	37	Active
340	M58	X	-0.024	-0.019	37	38	Active
341	M58	X	-0.019	-0.014	38	39	Active
342	M58	X	-0.014	-0.008	39	40	Active
343	M58	X	-0.008	-0.003	40	41	Active
344	M63	X	-0.003	-0.008	1	2	Active
345	M63	X	-0.008	-0.014	2	3	Active
346	M63	X	-0.014	-0.019	3	4	Active
347	M63	X	-0.019	-0.024	4	5	Active
348	M63	X	-0.024	-0.03	5	6	Active
349	M63	X	-0.03	-0.035	6	7	Active
350	M63	X	-0.035	-0.041	7	8	Active
351	M63	X	-0.041	-0.046	8	9	Active
352	M63	X	-0.046	-0.051	9	10	Active
353	M63	X	-0.051	-0.057	10	11	Active
354	M63	X	-0.057	-0.06	11	12	Active
355	M63	X	-0.06	-0.057	12	13	Active
356	M63	X	-0.057	-0.051	13	14	Active
357	M63	X	-0.051	-0.046	14	15	Active
358	M63	X	-0.046	-0.041	15	16	Active
359	M63	X	-0.041	-0.035	16	17	Active
360	M63	X	-0.035	-0.03	17	18	Active
361	M63	X	-0.03	-0.024	18	19	Active
362	M63	X	-0.024	-0.019	19	20	Active
363	M63	X	-0.019	-0.014	20	21	Active
364	M63	X	-0.014	-0.008	21	22	Active
365	M63	X	-0.008	-0.003	22	23	Active
366	M64	X	-0.003	-0.008	1	2	Active
367	M64	X	-0.008	-0.014	2	3	Active
368	M64	X	-0.014	-0.019	3	4	Active
369	M64	X	-0.019	-0.024	4	5	Active
370	M64	X	-0.024	-0.03	5	6	Active
371	M64	X	-0.03	-0.035	6	7	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
372	M64	X	-0.035	-0.041	7	8	Active
373	M64	X	-0.041	-0.046	8	9	Active
374	M64	X	-0.046	-0.051	9	10	Active
375	M64	X	-0.051	-0.057	10	11	Active
376	M64	X	-0.057	-0.062	11	12	Active
377	M64	X	-0.062	-0.068	12	13	Active
378	M64	X	-0.068	-0.073	13	14	Active
379	M64	X	-0.073	-0.078	14	15	Active
380	M64	X	-0.078	-0.084	15	16	Active
381	M64	X	-0.084	-0.086	16	17	Active
382	M64	X	-0.086	-0.086	17	18	Active
383	M64	X	-0.086	-0.086	18	19	Active
384	M64	X	-0.086	-0.086	19	20	Active
385	M64	X	-0.086	-0.086	20	21	Active
386	M64	X	-0.086	-0.086	21	22	Active
387	M64	X	-0.086	-0.086	22	23	Active
388	M64	X	-0.086	-0.086	23	24	Active
389	M64	X	-0.086	-0.086	24	25	Active
390	M64	X	-0.086	-0.084	25	26	Active
391	M64	X	-0.084	-0.078	26	27	Active
392	M64	X	-0.078	-0.073	27	28	Active
393	M64	X	-0.073	-0.068	28	29	Active
394	M64	X	-0.068	-0.062	29	30	Active
395	M64	X	-0.062	-0.057	30	31	Active
396	M64	X	-0.057	-0.051	31	32	Active
397	M64	X	-0.051	-0.046	32	33	Active
398	M64	X	-0.046	-0.041	33	34	Active
399	M64	X	-0.041	-0.035	34	35	Active
400	M64	X	-0.035	-0.03	35	36	Active
401	M64	X	-0.03	-0.024	36	37	Active
402	M64	X	-0.024	-0.019	37	38	Active
403	M64	X	-0.019	-0.014	38	39	Active
404	M64	X	-0.014	-0.008	39	40	Active
405	M64	X	-0.008	-0.003	40	41	Active
406	M69	X	-0.003	-0.008	1	2	Active
407	M69	X	-0.008	-0.014	2	3	Active
408	M69	X	-0.014	-0.019	3	4	Active
409	M69	X	-0.019	-0.024	4	5	Active
410	M69	X	-0.024	-0.03	5	6	Active
411	M69	X	-0.03	-0.035	6	7	Active
412	M69	X	-0.035	-0.041	7	8	Active
413	M69	X	-0.041	-0.046	8	9	Active
414	M69	X	-0.046	-0.051	9	10	Active
415	M69	X	-0.051	-0.057	10	11	Active
416	M69	X	-0.057	-0.06	11	12	Active
417	M69	X	-0.06	-0.057	12	13	Active
418	M69	X	-0.057	-0.051	13	14	Active
419	M69	X	-0.051	-0.046	14	15	Active
420	M69	X	-0.046	-0.041	15	16	Active
421	M69	X	-0.041	-0.035	16	17	Active
422	M69	X	-0.035	-0.03	17	18	Active
423	M69	X	-0.03	-0.024	18	19	Active
424	M69	X	-0.024	-0.019	19	20	Active
425	M69	X	-0.019	-0.014	20	21	Active
426	M69	X	-0.014	-0.008	21	22	Active
427	M69	X	-0.008	-0.003	22	23	Active
428	M70	X	-0.003	-0.008	1	2	Active
429	M70	X	-0.008	-0.014	2	3	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
430	M70	X	-0.014	-0.019	3	4	Active
431	M70	X	-0.019	-0.024	4	5	Active
432	M70	X	-0.024	-0.03	5	6	Active
433	M70	X	-0.03	-0.035	6	7	Active
434	M70	X	-0.035	-0.041	7	8	Active
435	M70	X	-0.041	-0.046	8	9	Active
436	M70	X	-0.046	-0.051	9	10	Active
437	M70	X	-0.051	-0.057	10	11	Active
438	M70	X	-0.057	-0.062	11	12	Active
439	M70	X	-0.062	-0.068	12	13	Active
440	M70	X	-0.068	-0.073	13	14	Active
441	M70	X	-0.073	-0.078	14	15	Active
442	M70	X	-0.078	-0.084	15	16	Active
443	M70	X	-0.084	-0.086	16	17	Active
444	M70	X	-0.086	-0.086	17	18	Active
445	M70	X	-0.086	-0.086	18	19	Active
446	M70	X	-0.086	-0.086	19	20	Active
447	M70	X	-0.086	-0.086	20	21	Active
448	M70	X	-0.086	-0.086	21	22	Active
449	M70	X	-0.086	-0.086	22	23	Active
450	M70	X	-0.086	-0.086	23	24	Active
451	M70	X	-0.086	-0.086	24	25	Active
452	M70	X	-0.086	-0.084	25	26	Active
453	M70	X	-0.084	-0.078	26	27	Active
454	M70	X	-0.078	-0.073	27	28	Active
455	M70	X	-0.073	-0.068	28	29	Active
456	M70	X	-0.068	-0.062	29	30	Active
457	M70	X	-0.062	-0.057	30	31	Active
458	M70	X	-0.057	-0.051	31	32	Active
459	M70	X	-0.051	-0.046	32	33	Active
460	M70	X	-0.046	-0.041	33	34	Active
461	M70	X	-0.041	-0.035	34	35	Active
462	M70	X	-0.035	-0.03	35	36	Active
463	M70	X	-0.03	-0.024	36	37	Active
464	M70	X	-0.024	-0.019	37	38	Active
465	M70	X	-0.019	-0.014	38	39	Active
466	M70	X	-0.014	-0.008	39	40	Active
467	M70	X	-0.008	-0.003	40	41	Active
468	M75	X	-0.003	-0.008	1	2	Active
469	M75	X	-0.008	-0.014	2	3	Active
470	M75	X	-0.014	-0.019	3	4	Active
471	M75	X	-0.019	-0.024	4	5	Active
472	M75	X	-0.024	-0.03	5	6	Active
473	M75	X	-0.03	-0.035	6	7	Active
474	M75	X	-0.035	-0.041	7	8	Active
475	M75	X	-0.041	-0.046	8	9	Active
476	M75	X	-0.046	-0.051	9	10	Active
477	M75	X	-0.051	-0.057	10	11	Active
478	M75	X	-0.057	-0.06	11	12	Active
479	M75	X	-0.06	-0.057	12	13	Active
480	M75	X	-0.057	-0.051	13	14	Active
481	M75	X	-0.051	-0.046	14	15	Active
482	M75	X	-0.046	-0.041	15	16	Active
483	M75	X	-0.041	-0.035	16	17	Active
484	M75	X	-0.035	-0.03	17	18	Active
485	M75	X	-0.03	-0.024	18	19	Active
486	M75	X	-0.024	-0.019	19	20	Active
487	M75	X	-0.019	-0.014	20	21	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
488	M75	X	-0.014	-0.008	21	22	Active
489	M75	X	-0.008	-0.003	22	23	Active
490	M76	X	-0.003	-0.008	1	2	Active
491	M76	X	-0.008	-0.014	2	3	Active
492	M76	X	-0.014	-0.019	3	4	Active
493	M76	X	-0.019	-0.024	4	5	Active
494	M76	X	-0.024	-0.03	5	6	Active
495	M76	X	-0.03	-0.035	6	7	Active
496	M76	X	-0.035	-0.041	7	8	Active
497	M76	X	-0.041	-0.046	8	9	Active
498	M76	X	-0.046	-0.051	9	10	Active
499	M76	X	-0.051	-0.057	10	11	Active
500	M76	X	-0.057	-0.062	11	12	Active
501	M76	X	-0.062	-0.068	12	13	Active
502	M76	X	-0.068	-0.073	13	14	Active
503	M76	X	-0.073	-0.078	14	15	Active
504	M76	X	-0.078	-0.084	15	16	Active
505	M76	X	-0.084	-0.086	16	17	Active
506	M76	X	-0.086	-0.086	17	18	Active
507	M76	X	-0.086	-0.086	18	19	Active
508	M76	X	-0.086	-0.086	19	20	Active
509	M76	X	-0.086	-0.086	20	21	Active
510	M76	X	-0.086	-0.086	21	22	Active
511	M76	X	-0.086	-0.086	22	23	Active
512	M76	X	-0.086	-0.086	23	24	Active
513	M76	X	-0.086	-0.086	24	25	Active
514	M76	X	-0.086	-0.084	25	26	Active
515	M76	X	-0.084	-0.078	26	27	Active
516	M76	X	-0.078	-0.073	27	28	Active
517	M76	X	-0.073	-0.068	28	29	Active
518	M76	X	-0.068	-0.062	29	30	Active
519	M76	X	-0.062	-0.057	30	31	Active
520	M76	X	-0.057	-0.051	31	32	Active
521	M76	X	-0.051	-0.046	32	33	Active
522	M76	X	-0.046	-0.041	33	34	Active
523	M76	X	-0.041	-0.035	34	35	Active
524	M76	X	-0.035	-0.03	35	36	Active
525	M76	X	-0.03	-0.024	36	37	Active
526	M76	X	-0.024	-0.019	37	38	Active
527	M76	X	-0.019	-0.014	38	39	Active
528	M76	X	-0.014	-0.008	39	40	Active
529	M76	X	-0.008	-0.003	40	41	Active
530	M81	X	-0.003	-0.008	1	2	Active
531	M81	X	-0.008	-0.014	2	3	Active
532	M81	X	-0.014	-0.019	3	4	Active
533	M81	X	-0.019	-0.024	4	5	Active
534	M81	X	-0.024	-0.03	5	6	Active
535	M81	X	-0.03	-0.035	6	7	Active
536	M81	X	-0.035	-0.041	7	8	Active
537	M81	X	-0.041	-0.046	8	9	Active
538	M81	X	-0.046	-0.051	9	10	Active
539	M81	X	-0.051	-0.057	10	11	Active
540	M81	X	-0.057	-0.06	11	12	Active
541	M81	X	-0.06	-0.057	12	13	Active
542	M81	X	-0.057	-0.051	13	14	Active
543	M81	X	-0.051	-0.046	14	15	Active
544	M81	X	-0.046	-0.041	15	16	Active
545	M81	X	-0.041	-0.035	16	17	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
546	M81	X	-0.035	-0.03	17	18	Active
547	M81	X	-0.03	-0.024	18	19	Active
548	M81	X	-0.024	-0.019	19	20	Active
549	M81	X	-0.019	-0.014	20	21	Active
550	M81	X	-0.014	-0.008	21	22	Active
551	M81	X	-0.008	-0.003	22	23	Active
552	M82	X	-0.003	-0.008	1	2	Active
553	M82	X	-0.008	-0.014	2	3	Active
554	M82	X	-0.014	-0.019	3	4	Active
555	M82	X	-0.019	-0.024	4	5	Active
556	M82	X	-0.024	-0.03	5	6	Active
557	M82	X	-0.03	-0.035	6	7	Active
558	M82	X	-0.035	-0.041	7	8	Active
559	M82	X	-0.041	-0.046	8	9	Active
560	M82	X	-0.046	-0.051	9	10	Active
561	M82	X	-0.051	-0.057	10	11	Active
562	M82	X	-0.057	-0.062	11	12	Active
563	M82	X	-0.062	-0.068	12	13	Active
564	M82	X	-0.068	-0.073	13	14	Active
565	M82	X	-0.073	-0.078	14	15	Active
566	M82	X	-0.078	-0.084	15	16	Active
567	M82	X	-0.084	-0.086	16	17	Active
568	M82	X	-0.086	-0.086	17	18	Active
569	M82	X	-0.086	-0.086	18	19	Active
570	M82	X	-0.086	-0.086	19	20	Active
571	M82	X	-0.086	-0.086	20	21	Active
572	M82	X	-0.086	-0.086	21	22	Active
573	M82	X	-0.086	-0.086	22	23	Active
574	M82	X	-0.086	-0.086	23	24	Active
575	M82	X	-0.086	-0.086	24	25	Active
576	M82	X	-0.086	-0.084	25	26	Active
577	M82	X	-0.084	-0.078	26	27	Active
578	M82	X	-0.078	-0.073	27	28	Active
579	M82	X	-0.073	-0.068	28	29	Active
580	M82	X	-0.068	-0.062	29	30	Active
581	M82	X	-0.062	-0.057	30	31	Active
582	M82	X	-0.057	-0.051	31	32	Active
583	M82	X	-0.051	-0.046	32	33	Active
584	M82	X	-0.046	-0.041	33	34	Active
585	M82	X	-0.041	-0.035	34	35	Active
586	M82	X	-0.035	-0.03	35	36	Active
587	M82	X	-0.03	-0.024	36	37	Active
588	M82	X	-0.024	-0.019	37	38	Active
589	M82	X	-0.019	-0.014	38	39	Active
590	M82	X	-0.014	-0.008	39	40	Active
591	M82	X	-0.008	-0.003	40	41	Active
592	M87	X	-0.003	-0.008	1	2	Active
593	M87	X	-0.008	-0.014	2	3	Active
594	M87	X	-0.014	-0.019	3	4	Active
595	M87	X	-0.019	-0.024	4	5	Active
596	M87	X	-0.024	-0.03	5	6	Active
597	M87	X	-0.03	-0.035	6	7	Active
598	M87	X	-0.035	-0.041	7	8	Active
599	M87	X	-0.041	-0.046	8	9	Active
600	M87	X	-0.046	-0.051	9	10	Active
601	M87	X	-0.051	-0.057	10	11	Active
602	M87	X	-0.057	-0.06	11	12	Active
603	M87	X	-0.06	-0.057	12	13	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
604	M87	X	-0.057	-0.051	13	14	Active
605	M87	X	-0.051	-0.046	14	15	Active
606	M87	X	-0.046	-0.041	15	16	Active
607	M87	X	-0.041	-0.035	16	17	Active
608	M87	X	-0.035	-0.03	17	18	Active
609	M87	X	-0.03	-0.024	18	19	Active
610	M87	X	-0.024	-0.019	19	20	Active
611	M87	X	-0.019	-0.014	20	21	Active
612	M87	X	-0.014	-0.008	21	22	Active
613	M87	X	-0.008	-0.003	22	23	Active
614	M88	X	-0.003	-0.008	1	2	Active
615	M88	X	-0.008	-0.014	2	3	Active
616	M88	X	-0.014	-0.019	3	4	Active
617	M88	X	-0.019	-0.024	4	5	Active
618	M88	X	-0.024	-0.03	5	6	Active
619	M88	X	-0.03	-0.035	6	7	Active
620	M88	X	-0.035	-0.041	7	8	Active
621	M88	X	-0.041	-0.046	8	9	Active
622	M88	X	-0.046	-0.051	9	10	Active
623	M88	X	-0.051	-0.057	10	11	Active
624	M88	X	-0.057	-0.062	11	12	Active
625	M88	X	-0.062	-0.068	12	13	Active
626	M88	X	-0.068	-0.073	13	14	Active
627	M88	X	-0.073	-0.078	14	15	Active
628	M88	X	-0.078	-0.084	15	16	Active
629	M88	X	-0.084	-0.086	16	17	Active
630	M88	X	-0.086	-0.086	17	18	Active
631	M88	X	-0.086	-0.086	18	19	Active
632	M88	X	-0.086	-0.086	19	20	Active
633	M88	X	-0.086	-0.086	20	21	Active
634	M88	X	-0.086	-0.086	21	22	Active
635	M88	X	-0.086	-0.086	22	23	Active
636	M88	X	-0.086	-0.086	23	24	Active
637	M88	X	-0.086	-0.086	24	25	Active
638	M88	X	-0.086	-0.084	25	26	Active
639	M88	X	-0.084	-0.078	26	27	Active
640	M88	X	-0.078	-0.073	27	28	Active
641	M88	X	-0.073	-0.068	28	29	Active
642	M88	X	-0.068	-0.062	29	30	Active
643	M88	X	-0.062	-0.057	30	31	Active
644	M88	X	-0.057	-0.051	31	32	Active
645	M88	X	-0.051	-0.046	32	33	Active
646	M88	X	-0.046	-0.041	33	34	Active
647	M88	X	-0.041	-0.035	34	35	Active
648	M88	X	-0.035	-0.03	35	36	Active
649	M88	X	-0.03	-0.024	36	37	Active
650	M88	X	-0.024	-0.019	37	38	Active
651	M88	X	-0.019	-0.014	38	39	Active
652	M88	X	-0.014	-0.008	39	40	Active
653	M88	X	-0.008	-0.003	40	41	Active
654	M93	X	-0.003	-0.008	1	2	Active
655	M93	X	-0.008	-0.014	2	3	Active
656	M93	X	-0.014	-0.019	3	4	Active
657	M93	X	-0.019	-0.024	4	5	Active
658	M93	X	-0.024	-0.03	5	6	Active
659	M93	X	-0.03	-0.035	6	7	Active
660	M93	X	-0.035	-0.041	7	8	Active
661	M93	X	-0.041	-0.046	8	9	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
662	M93	X	-0.046	-0.051	9	10	Active
663	M93	X	-0.051	-0.057	10	11	Active
664	M93	X	-0.057	-0.06	11	12	Active
665	M93	X	-0.06	-0.057	12	13	Active
666	M93	X	-0.057	-0.051	13	14	Active
667	M93	X	-0.051	-0.046	14	15	Active
668	M93	X	-0.046	-0.041	15	16	Active
669	M93	X	-0.041	-0.035	16	17	Active
670	M93	X	-0.035	-0.03	17	18	Active
671	M93	X	-0.03	-0.024	18	19	Active
672	M93	X	-0.024	-0.019	19	20	Active
673	M93	X	-0.019	-0.014	20	21	Active
674	M93	X	-0.014	-0.008	21	22	Active
675	M93	X	-0.008	-0.003	22	23	Active
676	M94	X	-0.003	-0.008	1	2	Active
677	M94	X	-0.008	-0.014	2	3	Active
678	M94	X	-0.014	-0.019	3	4	Active
679	M94	X	-0.019	-0.024	4	5	Active
680	M94	X	-0.024	-0.03	5	6	Active
681	M94	X	-0.03	-0.035	6	7	Active
682	M94	X	-0.035	-0.041	7	8	Active
683	M94	X	-0.041	-0.046	8	9	Active
684	M94	X	-0.046	-0.051	9	10	Active
685	M94	X	-0.051	-0.057	10	11	Active
686	M94	X	-0.057	-0.062	11	12	Active
687	M94	X	-0.062	-0.068	12	13	Active
688	M94	X	-0.068	-0.073	13	14	Active
689	M94	X	-0.073	-0.078	14	15	Active
690	M94	X	-0.078	-0.084	15	16	Active
691	M94	X	-0.084	-0.086	16	17	Active
692	M94	X	-0.086	-0.086	17	18	Active
693	M94	X	-0.086	-0.086	18	19	Active
694	M94	X	-0.086	-0.086	19	20	Active
695	M94	X	-0.086	-0.086	20	21	Active
696	M94	X	-0.086	-0.086	21	22	Active
697	M94	X	-0.086	-0.086	22	23	Active
698	M94	X	-0.086	-0.086	23	24	Active
699	M94	X	-0.086	-0.086	24	25	Active
700	M94	X	-0.086	-0.084	25	26	Active
701	M94	X	-0.084	-0.078	26	27	Active
702	M94	X	-0.078	-0.073	27	28	Active
703	M94	X	-0.073	-0.068	28	29	Active
704	M94	X	-0.068	-0.062	29	30	Active
705	M94	X	-0.062	-0.057	30	31	Active
706	M94	X	-0.057	-0.051	31	32	Active
707	M94	X	-0.051	-0.046	32	33	Active
708	M94	X	-0.046	-0.041	33	34	Active
709	M94	X	-0.041	-0.035	34	35	Active
710	M94	X	-0.035	-0.03	35	36	Active
711	M94	X	-0.03	-0.024	36	37	Active
712	M94	X	-0.024	-0.019	37	38	Active
713	M94	X	-0.019	-0.014	38	39	Active
714	M94	X	-0.014	-0.008	39	40	Active
715	M94	X	-0.008	-0.003	40	41	Active
716	M99	X	-0.003	-0.008	1	2	Active
717	M99	X	-0.008	-0.014	2	3	Active
718	M99	X	-0.014	-0.019	3	4	Active
719	M99	X	-0.019	-0.024	4	5	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
720	M99	X	-0.024	-0.03	5	6	Active
721	M99	X	-0.03	-0.035	6	7	Active
722	M99	X	-0.035	-0.041	7	8	Active
723	M99	X	-0.041	-0.046	8	9	Active
724	M99	X	-0.046	-0.051	9	10	Active
725	M99	X	-0.051	-0.057	10	11	Active
726	M99	X	-0.057	-0.06	11	12	Active
727	M99	X	-0.06	-0.057	12	13	Active
728	M99	X	-0.057	-0.051	13	14	Active
729	M99	X	-0.051	-0.046	14	15	Active
730	M99	X	-0.046	-0.041	15	16	Active
731	M99	X	-0.041	-0.035	16	17	Active
732	M99	X	-0.035	-0.03	17	18	Active
733	M99	X	-0.03	-0.024	18	19	Active
734	M99	X	-0.024	-0.019	19	20	Active
735	M99	X	-0.019	-0.014	20	21	Active
736	M99	X	-0.014	-0.008	21	22	Active
737	M99	X	-0.008	-0.003	22	23	Active
738	M100	X	-0.003	-0.008	1	2	Active
739	M100	X	-0.008	-0.014	2	3	Active
740	M100	X	-0.014	-0.019	3	4	Active
741	M100	X	-0.019	-0.024	4	5	Active
742	M100	X	-0.024	-0.03	5	6	Active
743	M100	X	-0.03	-0.035	6	7	Active
744	M100	X	-0.035	-0.041	7	8	Active
745	M100	X	-0.041	-0.046	8	9	Active
746	M100	X	-0.046	-0.051	9	10	Active
747	M100	X	-0.051	-0.057	10	11	Active
748	M100	X	-0.057	-0.062	11	12	Active
749	M100	X	-0.062	-0.068	12	13	Active
750	M100	X	-0.068	-0.073	13	14	Active
751	M100	X	-0.073	-0.078	14	15	Active
752	M100	X	-0.078	-0.084	15	16	Active
753	M100	X	-0.084	-0.086	16	17	Active
754	M100	X	-0.086	-0.086	17	18	Active
755	M100	X	-0.086	-0.086	18	19	Active
756	M100	X	-0.086	-0.086	19	20	Active
757	M100	X	-0.086	-0.086	20	21	Active
758	M100	X	-0.086	-0.086	21	22	Active
759	M100	X	-0.086	-0.086	22	23	Active
760	M100	X	-0.086	-0.086	23	24	Active
761	M100	X	-0.086	-0.086	24	25	Active
762	M100	X	-0.086	-0.084	25	26	Active
763	M100	X	-0.084	-0.078	26	27	Active
764	M100	X	-0.078	-0.073	27	28	Active
765	M100	X	-0.073	-0.068	28	29	Active
766	M100	X	-0.068	-0.062	29	30	Active
767	M100	X	-0.062	-0.057	30	31	Active
768	M100	X	-0.057	-0.051	31	32	Active
769	M100	X	-0.051	-0.046	32	33	Active
770	M100	X	-0.046	-0.041	33	34	Active
771	M100	X	-0.041	-0.035	34	35	Active
772	M100	X	-0.035	-0.03	35	36	Active
773	M100	X	-0.03	-0.024	36	37	Active
774	M100	X	-0.024	-0.019	37	38	Active
775	M100	X	-0.019	-0.014	38	39	Active
776	M100	X	-0.014	-0.008	39	40	Active
777	M100	X	-0.008	-0.003	40	41	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
778	M1	X	-0.376	-0.353	3.78e-14	1	Active
779	M1	X	-0.353	-0.33	1	2	Active
780	M1	X	-0.33	-0.308	2	3	Active
781	M1	X	-0.308	-0.285	3	4	Active
782	M1	X	-0.285	-0.262	4	5	Active
783	M1	X	-0.262	-0.239	5	6	Active
784	M1	X	-0.239	-0.217	6	7	Active
785	M1	X	-0.217	-0.194	7	8	Active
786	M1	X	-0.194	-0.171	8	9	Active
787	M1	X	-0.171	-0.148	9	10	Active
788	M1	X	-0.148	-0.125	10	11	Active
789	M1	X	-0.125	-0.103	11	12	Active
790	M1	X	-0.103	-0.08	12	13	Active
791	M1	X	-0.08	-0.057	13	14	Active
792	M1	X	-0.057	-0.034	14	15	Active
793	M1	X	-0.034	-0.011	15	16	Active
794	M5	X	-0.65	-0.627	4.441e-16	1	Active
795	M5	X	-0.627	-0.604	1	2	Active
796	M5	X	-0.604	-0.582	2	3	Active
797	M5	X	-0.582	-0.559	3	4	Active
798	M5	X	-0.559	-0.525	4	5	Active
799	M5	X	-0.525	-0.479	5	6	Active
800	M5	X	-0.479	-0.433	6	7	Active
801	M5	X	-0.433	-0.388	7	8	Active
802	M5	X	-0.388	-0.342	8	9	Active
803	M5	X	-0.342	-0.297	9	10	Active
804	M5	X	-0.297	-0.251	10	11	Active
805	M5	X	-0.251	-0.205	11	12	Active
806	M5	X	-0.205	-0.16	12	13	Active
807	M5	X	-0.16	-0.114	13	14	Active
808	M5	X	-0.114	-0.069	14	15	Active
809	M5	X	-0.069	-0.023	15	16	Active
810	M7	X	-0.65	-0.627	4.441e-16	1	Active
811	M7	X	-0.627	-0.604	1	2	Active
812	M7	X	-0.604	-0.582	2	3	Active
813	M7	X	-0.582	-0.559	3	4	Active
814	M7	X	-0.559	-0.525	4	5	Active
815	M7	X	-0.525	-0.479	5	6	Active
816	M7	X	-0.479	-0.433	6	7	Active
817	M7	X	-0.433	-0.388	7	8	Active
818	M7	X	-0.388	-0.342	8	9	Active
819	M7	X	-0.342	-0.297	9	10	Active
820	M7	X	-0.297	-0.251	10	11	Active
821	M7	X	-0.251	-0.205	11	12	Active
822	M7	X	-0.205	-0.16	12	13	Active
823	M7	X	-0.16	-0.114	13	14	Active
824	M7	X	-0.114	-0.069	14	15	Active
825	M7	X	-0.069	-0.023	15	16	Active
826	M9	X	-0.65	-0.627	4.441e-16	1	Active
827	M9	X	-0.627	-0.604	1	2	Active
828	M9	X	-0.604	-0.582	2	3	Active
829	M9	X	-0.582	-0.559	3	4	Active
830	M9	X	-0.559	-0.525	4	5	Active
831	M9	X	-0.525	-0.479	5	6	Active
832	M9	X	-0.479	-0.433	6	7	Active
833	M9	X	-0.433	-0.388	7	8	Active
834	M9	X	-0.388	-0.342	8	9	Active
835	M9	X	-0.342	-0.297	9	10	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
836	M9	X	-0.297	-0.251	10	11	Active
837	M9	X	-0.251	-0.205	11	12	Active
838	M9	X	-0.205	-0.16	12	13	Active
839	M9	X	-0.16	-0.114	13	14	Active
840	M9	X	-0.114	-0.069	14	15	Active
841	M9	X	-0.069	-0.023	15	16	Active
842	M11	X	-0.65	-0.627	4.441e-16	1	Active
843	M11	X	-0.627	-0.604	1	2	Active
844	M11	X	-0.604	-0.582	2	3	Active
845	M11	X	-0.582	-0.559	3	4	Active
846	M11	X	-0.559	-0.525	4	5	Active
847	M11	X	-0.525	-0.479	5	6	Active
848	M11	X	-0.479	-0.433	6	7	Active
849	M11	X	-0.433	-0.388	7	8	Active
850	M11	X	-0.388	-0.342	8	9	Active
851	M11	X	-0.342	-0.297	9	10	Active
852	M11	X	-0.297	-0.251	10	11	Active
853	M11	X	-0.251	-0.205	11	12	Active
854	M11	X	-0.205	-0.16	12	13	Active
855	M11	X	-0.16	-0.114	13	14	Active
856	M11	X	-0.114	-0.069	14	15	Active
857	M11	X	-0.069	-0.023	15	16	Active
858	M13	X	-0.65	-0.627	4.441e-16	1	Active
859	M13	X	-0.627	-0.604	1	2	Active
860	M13	X	-0.604	-0.582	2	3	Active
861	M13	X	-0.582	-0.559	3	4	Active
862	M13	X	-0.559	-0.525	4	5	Active
863	M13	X	-0.525	-0.479	5	6	Active
864	M13	X	-0.479	-0.433	6	7	Active
865	M13	X	-0.433	-0.388	7	8	Active
866	M13	X	-0.388	-0.342	8	9	Active
867	M13	X	-0.342	-0.297	9	10	Active
868	M13	X	-0.297	-0.251	10	11	Active
869	M13	X	-0.251	-0.205	11	12	Active
870	M13	X	-0.205	-0.16	12	13	Active
871	M13	X	-0.16	-0.114	13	14	Active
872	M13	X	-0.114	-0.069	14	15	Active
873	M13	X	-0.069	-0.023	15	16	Active
874	M15	X	-0.65	-0.627	4.441e-16	1	Active
875	M15	X	-0.627	-0.604	1	2	Active
876	M15	X	-0.604	-0.582	2	3	Active
877	M15	X	-0.582	-0.559	3	4	Active
878	M15	X	-0.559	-0.525	4	5	Active
879	M15	X	-0.525	-0.479	5	6	Active
880	M15	X	-0.479	-0.433	6	7	Active
881	M15	X	-0.433	-0.388	7	8	Active
882	M15	X	-0.388	-0.342	8	9	Active
883	M15	X	-0.342	-0.297	9	10	Active
884	M15	X	-0.297	-0.251	10	11	Active
885	M15	X	-0.251	-0.205	11	12	Active
886	M15	X	-0.205	-0.16	12	13	Active
887	M15	X	-0.16	-0.114	13	14	Active
888	M15	X	-0.114	-0.069	14	15	Active
889	M15	X	-0.069	-0.023	15	16	Active
890	M17	X	-0.65	-0.627	4.441e-16	1	Active
891	M17	X	-0.627	-0.604	1	2	Active
892	M17	X	-0.604	-0.582	2	3	Active
893	M17	X	-0.582	-0.559	3	4	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
894	M17	X	-0.559	-0.525	4	5	Active
895	M17	X	-0.525	-0.479	5	6	Active
896	M17	X	-0.479	-0.433	6	7	Active
897	M17	X	-0.433	-0.388	7	8	Active
898	M17	X	-0.388	-0.342	8	9	Active
899	M17	X	-0.342	-0.297	9	10	Active
900	M17	X	-0.297	-0.251	10	11	Active
901	M17	X	-0.251	-0.205	11	12	Active
902	M17	X	-0.205	-0.16	12	13	Active
903	M17	X	-0.16	-0.114	13	14	Active
904	M17	X	-0.114	-0.069	14	15	Active
905	M17	X	-0.069	-0.023	15	16	Active
906	M19	X	-0.74	-0.694	0	1	Active
907	M19	X	-0.694	-0.648	1	2	Active
908	M19	X	-0.648	-0.601	2	3	Active
909	M19	X	-0.601	-0.555	3	4	Active
910	M19	X	-0.555	-0.509	4	5	Active
911	M19	X	-0.509	-0.463	5	6	Active
912	M19	X	-0.463	-0.416	6	7	Active
913	M19	X	-0.416	-0.37	7	8	Active
914	M19	X	-0.37	-0.324	8	9	Active
915	M19	X	-0.324	-0.277	9	10	Active
916	M19	X	-0.277	-0.231	10	11	Active
917	M19	X	-0.231	-0.185	11	12	Active
918	M19	X	-0.185	-0.139	12	13	Active
919	M19	X	-0.139	-0.092	13	14	Active
920	M19	X	-0.092	-0.046	14	15	Active
921	M19	X	-0.046	0.0003561	15	16	Active
922	M21	X	-0.364	-0.341	0	1	Active
923	M21	X	-0.341	-0.317	1	2	Active
924	M21	X	-0.317	-0.294	2	3	Active
925	M21	X	-0.294	-0.27	3	4	Active
926	M21	X	-0.27	-0.247	4	5	Active
927	M21	X	-0.247	-0.223	5	6	Active
928	M21	X	-0.223	-0.2	6	7	Active
929	M21	X	-0.2	-0.176	7	8	Active
930	M21	X	-0.176	-0.153	8	9	Active
931	M21	X	-0.153	-0.129	9	10	Active
932	M21	X	-0.129	-0.106	10	11	Active
933	M21	X	-0.106	-0.082	11	12	Active
934	M21	X	-0.082	-0.059	12	13	Active
935	M21	X	-0.059	-0.035	13	14	Active
936	M21	X	-0.035	-0.012	14	15	Active
937	M45	X	-0.65	-0.627	1.221e-15	1	Active
938	M45	X	-0.627	-0.604	1	2	Active
939	M45	X	-0.604	-0.582	2	3	Active
940	M45	X	-0.582	-0.559	3	4	Active
941	M45	X	-0.559	-0.525	4	5	Active
942	M45	X	-0.525	-0.479	5	6	Active
943	M45	X	-0.479	-0.433	6	7	Active
944	M45	X	-0.433	-0.388	7	8	Active
945	M45	X	-0.388	-0.342	8	9	Active
946	M45	X	-0.342	-0.297	9	10	Active
947	M45	X	-0.297	-0.251	10	11	Active
948	M45	X	-0.251	-0.205	11	12	Active
949	M45	X	-0.205	-0.16	12	13	Active
950	M45	X	-0.16	-0.114	13	14	Active
951	M45	X	-0.114	-0.069	14	15	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
952	M45	X	-0.069	-0.023	15	16	Active
953	M46	X	-0.65	-0.627	1.221e-15	1	Active
954	M46	X	-0.627	-0.604	1	2	Active
955	M46	X	-0.604	-0.582	2	3	Active
956	M46	X	-0.582	-0.559	3	4	Active
957	M46	X	-0.559	-0.525	4	5	Active
958	M46	X	-0.525	-0.479	5	6	Active
959	M46	X	-0.479	-0.433	6	7	Active
960	M46	X	-0.433	-0.388	7	8	Active
961	M46	X	-0.388	-0.342	8	9	Active
962	M46	X	-0.342	-0.297	9	10	Active
963	M46	X	-0.297	-0.251	10	11	Active
964	M46	X	-0.251	-0.205	11	12	Active
965	M46	X	-0.205	-0.16	12	13	Active
966	M46	X	-0.16	-0.114	13	14	Active
967	M46	X	-0.114	-0.069	14	15	Active
968	M46	X	-0.069	-0.023	15	16	Active
969	M47	X	-0.65	-0.627	1.221e-15	1	Active
970	M47	X	-0.627	-0.604	1	2	Active
971	M47	X	-0.604	-0.582	2	3	Active
972	M47	X	-0.582	-0.559	3	4	Active
973	M47	X	-0.559	-0.525	4	5	Active
974	M47	X	-0.525	-0.479	5	6	Active
975	M47	X	-0.479	-0.433	6	7	Active
976	M47	X	-0.433	-0.388	7	8	Active
977	M47	X	-0.388	-0.342	8	9	Active
978	M47	X	-0.342	-0.297	9	10	Active
979	M47	X	-0.297	-0.251	10	11	Active
980	M47	X	-0.251	-0.205	11	12	Active
981	M47	X	-0.205	-0.16	12	13	Active
982	M47	X	-0.16	-0.114	13	14	Active
983	M47	X	-0.114	-0.069	14	15	Active
984	M47	X	-0.069	-0.023	15	16	Active
985	M48	X	-0.65	-0.627	1.221e-15	1	Active
986	M48	X	-0.627	-0.604	1	2	Active
987	M48	X	-0.604	-0.582	2	3	Active
988	M48	X	-0.582	-0.559	3	4	Active
989	M48	X	-0.559	-0.525	4	5	Active
990	M48	X	-0.525	-0.479	5	6	Active
991	M48	X	-0.479	-0.433	6	7	Active
992	M48	X	-0.433	-0.388	7	8	Active
993	M48	X	-0.388	-0.342	8	9	Active
994	M48	X	-0.342	-0.297	9	10	Active
995	M48	X	-0.297	-0.251	10	11	Active
996	M48	X	-0.251	-0.205	11	12	Active
997	M48	X	-0.205	-0.16	12	13	Active
998	M48	X	-0.16	-0.114	13	14	Active
999	M48	X	-0.114	-0.069	14	15	Active
1000	M48	X	-0.069	-0.023	15	16	Active
1001	M49	X	-0.65	-0.627	1.221e-15	1	Active
1002	M49	X	-0.627	-0.604	1	2	Active
1003	M49	X	-0.604	-0.582	2	3	Active
1004	M49	X	-0.582	-0.559	3	4	Active
1005	M49	X	-0.559	-0.525	4	5	Active
1006	M49	X	-0.525	-0.479	5	6	Active
1007	M49	X	-0.479	-0.433	6	7	Active
1008	M49	X	-0.433	-0.388	7	8	Active
1009	M49	X	-0.388	-0.342	8	9	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1010	M49	X	-0.342	-0.297	9	10	Active
1011	M49	X	-0.297	-0.251	10	11	Active
1012	M49	X	-0.251	-0.205	11	12	Active
1013	M49	X	-0.205	-0.16	12	13	Active
1014	M49	X	-0.16	-0.114	13	14	Active
1015	M49	X	-0.114	-0.069	14	15	Active
1016	M49	X	-0.069	-0.023	15	16	Active
1017	M50	X	-0.65	-0.627	1.221e-15	1	Active
1018	M50	X	-0.627	-0.604	1	2	Active
1019	M50	X	-0.604	-0.582	2	3	Active
1020	M50	X	-0.582	-0.559	3	4	Active
1021	M50	X	-0.559	-0.525	4	5	Active
1022	M50	X	-0.525	-0.479	5	6	Active
1023	M50	X	-0.479	-0.433	6	7	Active
1024	M50	X	-0.433	-0.388	7	8	Active
1025	M50	X	-0.388	-0.342	8	9	Active
1026	M50	X	-0.342	-0.297	9	10	Active
1027	M50	X	-0.297	-0.251	10	11	Active
1028	M50	X	-0.251	-0.205	11	12	Active
1029	M50	X	-0.205	-0.16	12	13	Active
1030	M50	X	-0.16	-0.114	13	14	Active
1031	M50	X	-0.114	-0.069	14	15	Active
1032	M50	X	-0.069	-0.023	15	16	Active
1033	M51	X	-0.65	-0.627	1.221e-15	1	Active
1034	M51	X	-0.627	-0.604	1	2	Active
1035	M51	X	-0.604	-0.582	2	3	Active
1036	M51	X	-0.582	-0.559	3	4	Active
1037	M51	X	-0.559	-0.525	4	5	Active
1038	M51	X	-0.525	-0.479	5	6	Active
1039	M51	X	-0.479	-0.433	6	7	Active
1040	M51	X	-0.433	-0.388	7	8	Active
1041	M51	X	-0.388	-0.342	8	9	Active
1042	M51	X	-0.342	-0.297	9	10	Active
1043	M51	X	-0.297	-0.251	10	11	Active
1044	M51	X	-0.251	-0.205	11	12	Active
1045	M51	X	-0.205	-0.16	12	13	Active
1046	M51	X	-0.16	-0.114	13	14	Active
1047	M51	X	-0.114	-0.069	14	15	Active
1048	M51	X	-0.069	-0.023	15	16	Active
1049	M54	X	-0.012	-0.034	1	2	Active
1050	M54	X	-0.034	-0.057	2	3	Active
1051	M54	X	-0.057	-0.08	3	4	Active
1052	M54	X	-0.08	-0.103	4	5	Active
1053	M54	X	-0.103	-0.126	5	6	Active
1054	M54	X	-0.126	-0.148	6	7	Active
1055	M54	X	-0.148	-0.171	7	8	Active
1056	M54	X	-0.171	-0.194	8	9	Active
1057	M54	X	-0.194	-0.217	9	10	Active
1058	M54	X	-0.217	-0.24	10	11	Active
1059	M54	X	-0.24	-0.262	11	12	Active
1060	M54	X	-0.262	-0.285	12	13	Active
1061	M54	X	-0.285	-0.308	13	14	Active
1062	M54	X	-0.308	-0.331	14	15	Active
1063	M54	X	-0.331	-0.354	15	16	Active
1064	M54	X	-0.354	-0.365	16	17	Active
1065	M54	X	-0.365	-0.365	17	18	Active
1066	M54	X	-0.365	-0.365	18	19	Active
1067	M54	X	-0.365	-0.365	19	20	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1068	M54	X	-0.365	-0.365	20	21	Active
1069	M54	X	-0.365	-0.365	21	22	Active
1070	M54	X	-0.365	-0.365	22	23	Active
1071	M54	X	-0.365	-0.365	23	24	Active
1072	M54	X	-0.365	-0.365	24	25	Active
1073	M54	X	-0.365	-0.354	25	26	Active
1074	M54	X	-0.354	-0.331	26	27	Active
1075	M54	X	-0.331	-0.308	27	28	Active
1076	M54	X	-0.308	-0.285	28	29	Active
1077	M54	X	-0.285	-0.262	29	30	Active
1078	M54	X	-0.262	-0.24	30	31	Active
1079	M54	X	-0.24	-0.217	31	32	Active
1080	M54	X	-0.217	-0.194	32	33	Active
1081	M54	X	-0.194	-0.171	33	34	Active
1082	M54	X	-0.171	-0.148	34	35	Active
1083	M54	X	-0.148	-0.126	35	36	Active
1084	M54	X	-0.126	-0.103	36	37	Active
1085	M54	X	-0.103	-0.08	37	38	Active
1086	M54	X	-0.08	-0.057	38	39	Active
1087	M54	X	-0.057	-0.034	39	40	Active
1088	M54	X	-0.034	-0.012	40	41	Active
1089	M57	X	-0.012	-0.035	1	2	Active
1090	M57	X	-0.035	-0.057	2	3	Active
1091	M57	X	-0.057	-0.08	3	4	Active
1092	M57	X	-0.08	-0.103	4	5	Active
1093	M57	X	-0.103	-0.126	5	6	Active
1094	M57	X	-0.126	-0.149	6	7	Active
1095	M57	X	-0.149	-0.171	7	8	Active
1096	M57	X	-0.171	-0.194	8	9	Active
1097	M57	X	-0.194	-0.217	9	10	Active
1098	M57	X	-0.217	-0.24	10	11	Active
1099	M57	X	-0.24	-0.251	11	12	Active
1100	M57	X	-0.251	-0.24	12	13	Active
1101	M57	X	-0.24	-0.217	13	14	Active
1102	M57	X	-0.217	-0.194	14	15	Active
1103	M57	X	-0.194	-0.171	15	16	Active
1104	M57	X	-0.171	-0.149	16	17	Active
1105	M57	X	-0.149	-0.126	17	18	Active
1106	M57	X	-0.126	-0.103	18	19	Active
1107	M57	X	-0.103	-0.08	19	20	Active
1108	M57	X	-0.08	-0.057	20	21	Active
1109	M57	X	-0.057	-0.035	21	22	Active
1110	M57	X	-0.035	-0.012	22	23	Active
1111	M60	X	-0.012	-0.034	1	2	Active
1112	M60	X	-0.034	-0.057	2	3	Active
1113	M60	X	-0.057	-0.08	3	4	Active
1114	M60	X	-0.08	-0.103	4	5	Active
1115	M60	X	-0.103	-0.126	5	6	Active
1116	M60	X	-0.126	-0.148	6	7	Active
1117	M60	X	-0.148	-0.171	7	8	Active
1118	M60	X	-0.171	-0.194	8	9	Active
1119	M60	X	-0.194	-0.217	9	10	Active
1120	M60	X	-0.217	-0.24	10	11	Active
1121	M60	X	-0.24	-0.262	11	12	Active
1122	M60	X	-0.262	-0.285	12	13	Active
1123	M60	X	-0.285	-0.308	13	14	Active
1124	M60	X	-0.308	-0.331	14	15	Active
1125	M60	X	-0.331	-0.354	15	16	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1126	M60	X	-0.354	-0.365	16	17	Active
1127	M60	X	-0.365	-0.365	17	18	Active
1128	M60	X	-0.365	-0.365	18	19	Active
1129	M60	X	-0.365	-0.365	19	20	Active
1130	M60	X	-0.365	-0.365	20	21	Active
1131	M60	X	-0.365	-0.365	21	22	Active
1132	M60	X	-0.365	-0.365	22	23	Active
1133	M60	X	-0.365	-0.365	23	24	Active
1134	M60	X	-0.365	-0.365	24	25	Active
1135	M60	X	-0.365	-0.354	25	26	Active
1136	M60	X	-0.354	-0.331	26	27	Active
1137	M60	X	-0.331	-0.308	27	28	Active
1138	M60	X	-0.308	-0.285	28	29	Active
1139	M60	X	-0.285	-0.262	29	30	Active
1140	M60	X	-0.262	-0.24	30	31	Active
1141	M60	X	-0.24	-0.217	31	32	Active
1142	M60	X	-0.217	-0.194	32	33	Active
1143	M60	X	-0.194	-0.171	33	34	Active
1144	M60	X	-0.171	-0.148	34	35	Active
1145	M60	X	-0.148	-0.126	35	36	Active
1146	M60	X	-0.126	-0.103	36	37	Active
1147	M60	X	-0.103	-0.08	37	38	Active
1148	M60	X	-0.08	-0.057	38	39	Active
1149	M60	X	-0.057	-0.034	39	40	Active
1150	M60	X	-0.034	-0.012	40	41	Active
1151	M66	X	-0.012	-0.035	1	2	Active
1152	M66	X	-0.035	-0.057	2	3	Active
1153	M66	X	-0.057	-0.08	3	4	Active
1154	M66	X	-0.08	-0.103	4	5	Active
1155	M66	X	-0.103	-0.126	5	6	Active
1156	M66	X	-0.126	-0.149	6	7	Active
1157	M66	X	-0.149	-0.171	7	8	Active
1158	M66	X	-0.171	-0.194	8	9	Active
1159	M66	X	-0.194	-0.217	9	10	Active
1160	M66	X	-0.217	-0.24	10	11	Active
1161	M66	X	-0.24	-0.251	11	12	Active
1162	M66	X	-0.251	-0.24	12	13	Active
1163	M66	X	-0.24	-0.217	13	14	Active
1164	M66	X	-0.217	-0.194	14	15	Active
1165	M66	X	-0.194	-0.171	15	16	Active
1166	M66	X	-0.171	-0.149	16	17	Active
1167	M66	X	-0.149	-0.126	17	18	Active
1168	M66	X	-0.126	-0.103	18	19	Active
1169	M66	X	-0.103	-0.08	19	20	Active
1170	M66	X	-0.08	-0.057	20	21	Active
1171	M66	X	-0.057	-0.035	21	22	Active
1172	M66	X	-0.035	-0.012	22	23	Active
1173	M67	X	-0.012	-0.034	1	2	Active
1174	M67	X	-0.034	-0.057	2	3	Active
1175	M67	X	-0.057	-0.08	3	4	Active
1176	M67	X	-0.08	-0.103	4	5	Active
1177	M67	X	-0.103	-0.126	5	6	Active
1178	M67	X	-0.126	-0.148	6	7	Active
1179	M67	X	-0.148	-0.171	7	8	Active
1180	M67	X	-0.171	-0.194	8	9	Active
1181	M67	X	-0.194	-0.217	9	10	Active
1182	M67	X	-0.217	-0.24	10	11	Active
1183	M67	X	-0.24	-0.262	11	12	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1184	M67	X	-0.262	-0.285	12	13	Active
1185	M67	X	-0.285	-0.308	13	14	Active
1186	M67	X	-0.308	-0.331	14	15	Active
1187	M67	X	-0.331	-0.354	15	16	Active
1188	M67	X	-0.354	-0.365	16	17	Active
1189	M67	X	-0.365	-0.365	17	18	Active
1190	M67	X	-0.365	-0.365	18	19	Active
1191	M67	X	-0.365	-0.365	19	20	Active
1192	M67	X	-0.365	-0.365	20	21	Active
1193	M67	X	-0.365	-0.365	21	22	Active
1194	M67	X	-0.365	-0.365	22	23	Active
1195	M67	X	-0.365	-0.365	23	24	Active
1196	M67	X	-0.365	-0.365	24	25	Active
1197	M67	X	-0.365	-0.354	25	26	Active
1198	M67	X	-0.354	-0.331	26	27	Active
1199	M67	X	-0.331	-0.308	27	28	Active
1200	M67	X	-0.308	-0.285	28	29	Active
1201	M67	X	-0.285	-0.262	29	30	Active
1202	M67	X	-0.262	-0.24	30	31	Active
1203	M67	X	-0.24	-0.217	31	32	Active
1204	M67	X	-0.217	-0.194	32	33	Active
1205	M67	X	-0.194	-0.171	33	34	Active
1206	M67	X	-0.171	-0.148	34	35	Active
1207	M67	X	-0.148	-0.126	35	36	Active
1208	M67	X	-0.126	-0.103	36	37	Active
1209	M67	X	-0.103	-0.08	37	38	Active
1210	M67	X	-0.08	-0.057	38	39	Active
1211	M67	X	-0.057	-0.034	39	40	Active
1212	M67	X	-0.034	-0.012	40	41	Active
1213	M72	X	-0.012	-0.035	1	2	Active
1214	M72	X	-0.035	-0.057	2	3	Active
1215	M72	X	-0.057	-0.08	3	4	Active
1216	M72	X	-0.08	-0.103	4	5	Active
1217	M72	X	-0.103	-0.126	5	6	Active
1218	M72	X	-0.126	-0.149	6	7	Active
1219	M72	X	-0.149	-0.171	7	8	Active
1220	M72	X	-0.171	-0.194	8	9	Active
1221	M72	X	-0.194	-0.217	9	10	Active
1222	M72	X	-0.217	-0.24	10	11	Active
1223	M72	X	-0.24	-0.251	11	12	Active
1224	M72	X	-0.251	-0.24	12	13	Active
1225	M72	X	-0.24	-0.217	13	14	Active
1226	M72	X	-0.217	-0.194	14	15	Active
1227	M72	X	-0.194	-0.171	15	16	Active
1228	M72	X	-0.171	-0.149	16	17	Active
1229	M72	X	-0.149	-0.126	17	18	Active
1230	M72	X	-0.126	-0.103	18	19	Active
1231	M72	X	-0.103	-0.08	19	20	Active
1232	M72	X	-0.08	-0.057	20	21	Active
1233	M72	X	-0.057	-0.035	21	22	Active
1234	M72	X	-0.035	-0.012	22	23	Active
1235	M73	X	-0.012	-0.034	1	2	Active
1236	M73	X	-0.034	-0.057	2	3	Active
1237	M73	X	-0.057	-0.08	3	4	Active
1238	M73	X	-0.08	-0.103	4	5	Active
1239	M73	X	-0.103	-0.126	5	6	Active
1240	M73	X	-0.126	-0.148	6	7	Active
1241	M73	X	-0.148	-0.171	7	8	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1242	M73	X	-0.171	-0.194	8	9	Active
1243	M73	X	-0.194	-0.217	9	10	Active
1244	M73	X	-0.217	-0.24	10	11	Active
1245	M73	X	-0.24	-0.262	11	12	Active
1246	M73	X	-0.262	-0.285	12	13	Active
1247	M73	X	-0.285	-0.308	13	14	Active
1248	M73	X	-0.308	-0.331	14	15	Active
1249	M73	X	-0.331	-0.354	15	16	Active
1250	M73	X	-0.354	-0.365	16	17	Active
1251	M73	X	-0.365	-0.365	17	18	Active
1252	M73	X	-0.365	-0.365	18	19	Active
1253	M73	X	-0.365	-0.365	19	20	Active
1254	M73	X	-0.365	-0.365	20	21	Active
1255	M73	X	-0.365	-0.365	21	22	Active
1256	M73	X	-0.365	-0.365	22	23	Active
1257	M73	X	-0.365	-0.365	23	24	Active
1258	M73	X	-0.365	-0.365	24	25	Active
1259	M73	X	-0.365	-0.354	25	26	Active
1260	M73	X	-0.354	-0.331	26	27	Active
1261	M73	X	-0.331	-0.308	27	28	Active
1262	M73	X	-0.308	-0.285	28	29	Active
1263	M73	X	-0.285	-0.262	29	30	Active
1264	M73	X	-0.262	-0.24	30	31	Active
1265	M73	X	-0.24	-0.217	31	32	Active
1266	M73	X	-0.217	-0.194	32	33	Active
1267	M73	X	-0.194	-0.171	33	34	Active
1268	M73	X	-0.171	-0.148	34	35	Active
1269	M73	X	-0.148	-0.126	35	36	Active
1270	M73	X	-0.126	-0.103	36	37	Active
1271	M73	X	-0.103	-0.08	37	38	Active
1272	M73	X	-0.08	-0.057	38	39	Active
1273	M73	X	-0.057	-0.034	39	40	Active
1274	M73	X	-0.034	-0.012	40	41	Active
1275	M78	X	-0.012	-0.035	1	2	Active
1276	M78	X	-0.035	-0.057	2	3	Active
1277	M78	X	-0.057	-0.08	3	4	Active
1278	M78	X	-0.08	-0.103	4	5	Active
1279	M78	X	-0.103	-0.126	5	6	Active
1280	M78	X	-0.126	-0.149	6	7	Active
1281	M78	X	-0.149	-0.171	7	8	Active
1282	M78	X	-0.171	-0.194	8	9	Active
1283	M78	X	-0.194	-0.217	9	10	Active
1284	M78	X	-0.217	-0.24	10	11	Active
1285	M78	X	-0.24	-0.251	11	12	Active
1286	M78	X	-0.251	-0.24	12	13	Active
1287	M78	X	-0.24	-0.217	13	14	Active
1288	M78	X	-0.217	-0.194	14	15	Active
1289	M78	X	-0.194	-0.171	15	16	Active
1290	M78	X	-0.171	-0.149	16	17	Active
1291	M78	X	-0.149	-0.126	17	18	Active
1292	M78	X	-0.126	-0.103	18	19	Active
1293	M78	X	-0.103	-0.08	19	20	Active
1294	M78	X	-0.08	-0.057	20	21	Active
1295	M78	X	-0.057	-0.035	21	22	Active
1296	M78	X	-0.035	-0.012	22	23	Active
1297	M79	X	-0.012	-0.034	1	2	Active
1298	M79	X	-0.034	-0.057	2	3	Active
1299	M79	X	-0.057	-0.08	3	4	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1300	M79	X	-0.08	-0.103	4	5	Active
1301	M79	X	-0.103	-0.126	5	6	Active
1302	M79	X	-0.126	-0.148	6	7	Active
1303	M79	X	-0.148	-0.171	7	8	Active
1304	M79	X	-0.171	-0.194	8	9	Active
1305	M79	X	-0.194	-0.217	9	10	Active
1306	M79	X	-0.217	-0.24	10	11	Active
1307	M79	X	-0.24	-0.262	11	12	Active
1308	M79	X	-0.262	-0.285	12	13	Active
1309	M79	X	-0.285	-0.308	13	14	Active
1310	M79	X	-0.308	-0.331	14	15	Active
1311	M79	X	-0.331	-0.354	15	16	Active
1312	M79	X	-0.354	-0.365	16	17	Active
1313	M79	X	-0.365	-0.365	17	18	Active
1314	M79	X	-0.365	-0.365	18	19	Active
1315	M79	X	-0.365	-0.365	19	20	Active
1316	M79	X	-0.365	-0.365	20	21	Active
1317	M79	X	-0.365	-0.365	21	22	Active
1318	M79	X	-0.365	-0.365	22	23	Active
1319	M79	X	-0.365	-0.365	23	24	Active
1320	M79	X	-0.365	-0.365	24	25	Active
1321	M79	X	-0.365	-0.354	25	26	Active
1322	M79	X	-0.354	-0.331	26	27	Active
1323	M79	X	-0.331	-0.308	27	28	Active
1324	M79	X	-0.308	-0.285	28	29	Active
1325	M79	X	-0.285	-0.262	29	30	Active
1326	M79	X	-0.262	-0.24	30	31	Active
1327	M79	X	-0.24	-0.217	31	32	Active
1328	M79	X	-0.217	-0.194	32	33	Active
1329	M79	X	-0.194	-0.171	33	34	Active
1330	M79	X	-0.171	-0.148	34	35	Active
1331	M79	X	-0.148	-0.126	35	36	Active
1332	M79	X	-0.126	-0.103	36	37	Active
1333	M79	X	-0.103	-0.08	37	38	Active
1334	M79	X	-0.08	-0.057	38	39	Active
1335	M79	X	-0.057	-0.034	39	40	Active
1336	M79	X	-0.034	-0.012	40	41	Active
1337	M84	X	-0.012	-0.035	1	2	Active
1338	M84	X	-0.035	-0.057	2	3	Active
1339	M84	X	-0.057	-0.08	3	4	Active
1340	M84	X	-0.08	-0.103	4	5	Active
1341	M84	X	-0.103	-0.126	5	6	Active
1342	M84	X	-0.126	-0.149	6	7	Active
1343	M84	X	-0.149	-0.171	7	8	Active
1344	M84	X	-0.171	-0.194	8	9	Active
1345	M84	X	-0.194	-0.217	9	10	Active
1346	M84	X	-0.217	-0.24	10	11	Active
1347	M84	X	-0.24	-0.251	11	12	Active
1348	M84	X	-0.251	-0.24	12	13	Active
1349	M84	X	-0.24	-0.217	13	14	Active
1350	M84	X	-0.217	-0.194	14	15	Active
1351	M84	X	-0.194	-0.171	15	16	Active
1352	M84	X	-0.171	-0.149	16	17	Active
1353	M84	X	-0.149	-0.126	17	18	Active
1354	M84	X	-0.126	-0.103	18	19	Active
1355	M84	X	-0.103	-0.08	19	20	Active
1356	M84	X	-0.08	-0.057	20	21	Active
1357	M84	X	-0.057	-0.035	21	22	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1358	M84	X	-0.035	-0.012	22	23	Active
1359	M85	X	-0.012	-0.034	1	2	Active
1360	M85	X	-0.034	-0.057	2	3	Active
1361	M85	X	-0.057	-0.08	3	4	Active
1362	M85	X	-0.08	-0.103	4	5	Active
1363	M85	X	-0.103	-0.126	5	6	Active
1364	M85	X	-0.126	-0.148	6	7	Active
1365	M85	X	-0.148	-0.171	7	8	Active
1366	M85	X	-0.171	-0.194	8	9	Active
1367	M85	X	-0.194	-0.217	9	10	Active
1368	M85	X	-0.217	-0.24	10	11	Active
1369	M85	X	-0.24	-0.262	11	12	Active
1370	M85	X	-0.262	-0.285	12	13	Active
1371	M85	X	-0.285	-0.308	13	14	Active
1372	M85	X	-0.308	-0.331	14	15	Active
1373	M85	X	-0.331	-0.354	15	16	Active
1374	M85	X	-0.354	-0.365	16	17	Active
1375	M85	X	-0.365	-0.365	17	18	Active
1376	M85	X	-0.365	-0.365	18	19	Active
1377	M85	X	-0.365	-0.365	19	20	Active
1378	M85	X	-0.365	-0.365	20	21	Active
1379	M85	X	-0.365	-0.365	21	22	Active
1380	M85	X	-0.365	-0.365	22	23	Active
1381	M85	X	-0.365	-0.365	23	24	Active
1382	M85	X	-0.365	-0.365	24	25	Active
1383	M85	X	-0.365	-0.354	25	26	Active
1384	M85	X	-0.354	-0.331	26	27	Active
1385	M85	X	-0.331	-0.308	27	28	Active
1386	M85	X	-0.308	-0.285	28	29	Active
1387	M85	X	-0.285	-0.262	29	30	Active
1388	M85	X	-0.262	-0.24	30	31	Active
1389	M85	X	-0.24	-0.217	31	32	Active
1390	M85	X	-0.217	-0.194	32	33	Active
1391	M85	X	-0.194	-0.171	33	34	Active
1392	M85	X	-0.171	-0.148	34	35	Active
1393	M85	X	-0.148	-0.126	35	36	Active
1394	M85	X	-0.126	-0.103	36	37	Active
1395	M85	X	-0.103	-0.08	37	38	Active
1396	M85	X	-0.08	-0.057	38	39	Active
1397	M85	X	-0.057	-0.034	39	40	Active
1398	M85	X	-0.034	-0.012	40	41	Active
1399	M90	X	-0.012	-0.035	1	2	Active
1400	M90	X	-0.035	-0.057	2	3	Active
1401	M90	X	-0.057	-0.08	3	4	Active
1402	M90	X	-0.08	-0.103	4	5	Active
1403	M90	X	-0.103	-0.126	5	6	Active
1404	M90	X	-0.126	-0.149	6	7	Active
1405	M90	X	-0.149	-0.171	7	8	Active
1406	M90	X	-0.171	-0.194	8	9	Active
1407	M90	X	-0.194	-0.217	9	10	Active
1408	M90	X	-0.217	-0.24	10	11	Active
1409	M90	X	-0.24	-0.251	11	12	Active
1410	M90	X	-0.251	-0.24	12	13	Active
1411	M90	X	-0.24	-0.217	13	14	Active
1412	M90	X	-0.217	-0.194	14	15	Active
1413	M90	X	-0.194	-0.171	15	16	Active
1414	M90	X	-0.171	-0.149	16	17	Active
1415	M90	X	-0.149	-0.126	17	18	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1416	M90	X	-0.126	-0.103	18	19	Active
1417	M90	X	-0.103	-0.08	19	20	Active
1418	M90	X	-0.08	-0.057	20	21	Active
1419	M90	X	-0.057	-0.035	21	22	Active
1420	M90	X	-0.035	-0.012	22	23	Active
1421	M91	X	-0.012	-0.034	1	2	Active
1422	M91	X	-0.034	-0.057	2	3	Active
1423	M91	X	-0.057	-0.08	3	4	Active
1424	M91	X	-0.08	-0.103	4	5	Active
1425	M91	X	-0.103	-0.126	5	6	Active
1426	M91	X	-0.126	-0.148	6	7	Active
1427	M91	X	-0.148	-0.171	7	8	Active
1428	M91	X	-0.171	-0.194	8	9	Active
1429	M91	X	-0.194	-0.217	9	10	Active
1430	M91	X	-0.217	-0.24	10	11	Active
1431	M91	X	-0.24	-0.262	11	12	Active
1432	M91	X	-0.262	-0.285	12	13	Active
1433	M91	X	-0.285	-0.308	13	14	Active
1434	M91	X	-0.308	-0.331	14	15	Active
1435	M91	X	-0.331	-0.354	15	16	Active
1436	M91	X	-0.354	-0.365	16	17	Active
1437	M91	X	-0.365	-0.365	17	18	Active
1438	M91	X	-0.365	-0.365	18	19	Active
1439	M91	X	-0.365	-0.365	19	20	Active
1440	M91	X	-0.365	-0.365	20	21	Active
1441	M91	X	-0.365	-0.365	21	22	Active
1442	M91	X	-0.365	-0.365	22	23	Active
1443	M91	X	-0.365	-0.365	23	24	Active
1444	M91	X	-0.365	-0.365	24	25	Active
1445	M91	X	-0.365	-0.354	25	26	Active
1446	M91	X	-0.354	-0.331	26	27	Active
1447	M91	X	-0.331	-0.308	27	28	Active
1448	M91	X	-0.308	-0.285	28	29	Active
1449	M91	X	-0.285	-0.262	29	30	Active
1450	M91	X	-0.262	-0.24	30	31	Active
1451	M91	X	-0.24	-0.217	31	32	Active
1452	M91	X	-0.217	-0.194	32	33	Active
1453	M91	X	-0.194	-0.171	33	34	Active
1454	M91	X	-0.171	-0.148	34	35	Active
1455	M91	X	-0.148	-0.126	35	36	Active
1456	M91	X	-0.126	-0.103	36	37	Active
1457	M91	X	-0.103	-0.08	37	38	Active
1458	M91	X	-0.08	-0.057	38	39	Active
1459	M91	X	-0.057	-0.034	39	40	Active
1460	M91	X	-0.034	-0.012	40	41	Active
1461	M96	X	-0.012	-0.035	1	2	Active
1462	M96	X	-0.035	-0.057	2	3	Active
1463	M96	X	-0.057	-0.08	3	4	Active
1464	M96	X	-0.08	-0.103	4	5	Active
1465	M96	X	-0.103	-0.126	5	6	Active
1466	M96	X	-0.126	-0.149	6	7	Active
1467	M96	X	-0.149	-0.171	7	8	Active
1468	M96	X	-0.171	-0.194	8	9	Active
1469	M96	X	-0.194	-0.217	9	10	Active
1470	M96	X	-0.217	-0.24	10	11	Active
1471	M96	X	-0.24	-0.251	11	12	Active
1472	M96	X	-0.251	-0.24	12	13	Active
1473	M96	X	-0.24	-0.217	13	14	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1474	M96	X	-0.217	-0.194	14	15	Active
1475	M96	X	-0.194	-0.171	15	16	Active
1476	M96	X	-0.171	-0.149	16	17	Active
1477	M96	X	-0.149	-0.126	17	18	Active
1478	M96	X	-0.126	-0.103	18	19	Active
1479	M96	X	-0.103	-0.08	19	20	Active
1480	M96	X	-0.08	-0.057	20	21	Active
1481	M96	X	-0.057	-0.035	21	22	Active
1482	M96	X	-0.035	-0.012	22	23	Active
1483	M97	X	-0.012	-0.034	1	2	Active
1484	M97	X	-0.034	-0.057	2	3	Active
1485	M97	X	-0.057	-0.08	3	4	Active
1486	M97	X	-0.08	-0.103	4	5	Active
1487	M97	X	-0.103	-0.126	5	6	Active
1488	M97	X	-0.126	-0.148	6	7	Active
1489	M97	X	-0.148	-0.171	7	8	Active
1490	M97	X	-0.171	-0.194	8	9	Active
1491	M97	X	-0.194	-0.217	9	10	Active
1492	M97	X	-0.217	-0.24	10	11	Active
1493	M97	X	-0.24	-0.262	11	12	Active
1494	M97	X	-0.262	-0.285	12	13	Active
1495	M97	X	-0.285	-0.308	13	14	Active
1496	M97	X	-0.308	-0.331	14	15	Active
1497	M97	X	-0.331	-0.354	15	16	Active
1498	M97	X	-0.354	-0.365	16	17	Active
1499	M97	X	-0.365	-0.365	17	18	Active
1500	M97	X	-0.365	-0.365	18	19	Active
1501	M97	X	-0.365	-0.365	19	20	Active
1502	M97	X	-0.365	-0.365	20	21	Active
1503	M97	X	-0.365	-0.365	21	22	Active
1504	M97	X	-0.365	-0.365	22	23	Active
1505	M97	X	-0.365	-0.365	23	24	Active
1506	M97	X	-0.365	-0.365	24	25	Active
1507	M97	X	-0.365	-0.354	25	26	Active
1508	M97	X	-0.354	-0.331	26	27	Active
1509	M97	X	-0.331	-0.308	27	28	Active
1510	M97	X	-0.308	-0.285	28	29	Active
1511	M97	X	-0.285	-0.262	29	30	Active
1512	M97	X	-0.262	-0.24	30	31	Active
1513	M97	X	-0.24	-0.217	31	32	Active
1514	M97	X	-0.217	-0.194	32	33	Active
1515	M97	X	-0.194	-0.171	33	34	Active
1516	M97	X	-0.171	-0.148	34	35	Active
1517	M97	X	-0.148	-0.126	35	36	Active
1518	M97	X	-0.126	-0.103	36	37	Active
1519	M97	X	-0.103	-0.08	37	38	Active
1520	M97	X	-0.08	-0.057	38	39	Active
1521	M97	X	-0.057	-0.034	39	40	Active
1522	M97	X	-0.034	-0.012	40	41	Active
1523	M101	X	-0.012	-0.035	1.665e-15	1.031	Active
1524	M101	X	-0.035	-0.057	1.031	2.063	Active
1525	M101	X	-0.057	-0.08	2.063	3.094	Active
1526	M101	X	-0.08	-0.103	3.094	4.125	Active
1527	M101	X	-0.103	-0.126	4.125	5.156	Active
1528	M101	X	-0.126	-0.148	5.156	6.188	Active
1529	M101	X	-0.148	-0.171	6.188	7.219	Active
1530	M101	X	-0.171	-0.194	7.219	8.25	Active
1531	M101	X	-0.194	-0.217	8.25	9.281	Active

Member Distributed Loads (BLC 17 : BLC 6 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1532	M101	X	-0.217	-0.24	9.281	10.313	Active
1533	M101	X	-0.24	-0.262	10.313	11.344	Active
1534	M101	X	-0.262	-0.285	11.344	12.375	Active
1535	M101	X	-0.285	-0.308	12.375	13.406	Active
1536	M101	X	-0.308	-0.331	13.406	14.438	Active
1537	M101	X	-0.331	-0.354	14.438	15.469	Active
1538	M101	X	-0.354	-0.365	15.469	16.5	Active
1539	M101	X	-0.365	-0.354	16.5	17.531	Active
1540	M101	X	-0.354	-0.331	17.531	18.563	Active
1541	M101	X	-0.331	-0.308	18.563	19.594	Active
1542	M101	X	-0.308	-0.285	19.594	20.625	Active
1543	M101	X	-0.285	-0.262	20.625	21.656	Active
1544	M101	X	-0.262	-0.24	21.656	22.688	Active
1545	M101	X	-0.24	-0.217	22.688	23.719	Active
1546	M101	X	-0.217	-0.194	23.719	24.75	Active
1547	M101	X	-0.194	-0.171	24.75	25.781	Active
1548	M101	X	-0.171	-0.148	25.781	26.813	Active
1549	M101	X	-0.148	-0.126	26.813	27.844	Active
1550	M101	X	-0.126	-0.103	27.844	28.875	Active
1551	M101	X	-0.103	-0.08	28.875	29.906	Active
1552	M101	X	-0.08	-0.057	29.906	30.938	Active
1553	M101	X	-0.057	-0.035	30.938	31.969	Active
1554	M101	X	-0.035	-0.012	31.969	33	Active

Member Distributed Loads (BLC 19 : BLC 8 Transient Area Loads)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
1	M1	Z	-0.271	-0.271	1.665e-15	1	Active
2	M1	Z	-0.271	-0.271	1	2	Active
3	M1	Z	-0.271	-0.271	2	3	Active
4	M1	Z	-0.271	-0.271	3	4	Active
5	M1	Z	-0.271	-0.271	4	5	Active
6	M1	Z	-0.271	-0.271	5	6	Active
7	M1	Z	-0.271	-0.258	6	7	Active
8	M1	Z	-0.258	-0.231	7	8	Active
9	M1	Z	-0.231	-0.204	8	9	Active
10	M1	Z	-0.204	-0.177	9	10	Active
11	M1	Z	-0.177	-0.149	10	11	Active
12	M1	Z	-0.149	-0.122	11	12	Active
13	M1	Z	-0.122	-0.095	12	13	Active
14	M1	Z	-0.095	-0.068	13	14	Active
15	M1	Z	-0.068	-0.041	14	15	Active
16	M1	Z	-0.041	-0.014	15	16	Active
17	M2	Z	-0.516	-0.516	1.332e-15	1	Active
18	M2	Z	-0.516	-0.516	1	2	Active
19	M2	Z	-0.516	-0.516	2	3	Active
20	M2	Z	-0.516	-0.516	3	4	Active
21	M2	Z	-0.516	-0.516	4	5	Active
22	M2	Z	-0.516	-0.516	5	6	Active
23	M2	Z	-0.516	-0.502	6	7	Active
24	M2	Z	-0.502	-0.462	7	8	Active
25	M2	Z	-0.462	-0.407	8	9	Active
26	M2	Z	-0.407	-0.353	9	10	Active
27	M2	Z	-0.353	-0.299	10	11	Active
28	M2	Z	-0.299	-0.245	11	12	Active
29	M2	Z	-0.245	-0.191	12	13	Active
30	M2	Z	-0.191	-0.136	13	14	Active
31	M2	Z	-0.136	-0.082	14	15	Active
32	M2	Z	-0.082	-0.028	15	16	Active

Member Distributed Loads (BLC 19 : BLC 8 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
33	M3	Z	-0.244	-0.244	4.441e-16	1	Active
34	M3	Z	-0.244	-0.244	1	2	Active
35	M3	Z	-0.244	-0.244	2	3	Active
36	M3	Z	-0.244	-0.244	3	4	Active
37	M3	Z	-0.244	-0.244	4	5	Active
38	M3	Z	-0.244	-0.244	5	6	Active
39	M3	Z	-0.244	-0.244	6	7	Active
40	M3	Z	-0.244	-0.231	7	8	Active
41	M3	Z	-0.231	-0.204	8	9	Active
42	M3	Z	-0.204	-0.177	9	10	Active
43	M3	Z	-0.177	-0.149	10	11	Active
44	M3	Z	-0.149	-0.122	11	12	Active
45	M3	Z	-0.122	-0.095	12	13	Active
46	M3	Z	-0.095	-0.068	13	14	Active
47	M3	Z	-0.068	-0.041	14	15	Active
48	M3	Z	-0.041	-0.014	15	16	Active
49	M52	Z	-0.014	-0.041	1	2	Active
50	M52	Z	-0.041	-0.069	2	3	Active
51	M52	Z	-0.069	-0.096	3	4	Active
52	M52	Z	-0.096	-0.123	4	5	Active
53	M52	Z	-0.123	-0.15	5	6	Active
54	M52	Z	-0.15	-0.177	6	7	Active
55	M52	Z	-0.177	-0.204	7	8	Active
56	M52	Z	-0.204	-0.231	8	9	Active
57	M52	Z	-0.231	-0.245	9	10	Active
58	M52	Z	-0.245	-0.231	10	11	Active
59	M52	Z	-0.231	-0.204	11	12	Active
60	M52	Z	-0.204	-0.177	12	13	Active
61	M52	Z	-0.177	-0.15	13	14	Active
62	M52	Z	-0.15	-0.123	14	15	Active
63	M52	Z	-0.123	-0.096	15	16	Active
64	M52	Z	-0.096	-0.069	16	17	Active
65	M52	Z	-0.069	-0.041	17	18	Active
66	M52	Z	-0.041	-0.014	18	19	Active
67	M53	Z	-0.014	-0.041	1	2	Active
68	M53	Z	-0.041	-0.069	2	3	Active
69	M53	Z	-0.069	-0.096	3	4	Active
70	M53	Z	-0.096	-0.123	4	5	Active
71	M53	Z	-0.123	-0.15	5	6	Active
72	M53	Z	-0.15	-0.177	6	7	Active
73	M53	Z	-0.177	-0.204	7	8	Active
74	M53	Z	-0.204	-0.218	8	9	Active
75	M53	Z	-0.218	-0.204	9	10	Active
76	M53	Z	-0.204	-0.177	10	11	Active
77	M53	Z	-0.177	-0.15	11	12	Active
78	M53	Z	-0.15	-0.123	12	13	Active
79	M53	Z	-0.123	-0.096	13	14	Active
80	M53	Z	-0.096	-0.069	14	15	Active
81	M53	Z	-0.069	-0.041	15	16	Active
82	M53	Z	-0.041	-0.014	16	17	Active
83	M20	Z	0.514	0.514	1.332e-15	1	Active
84	M20	Z	0.514	0.514	1	2	Active
85	M20	Z	0.514	0.514	2	3	Active
86	M20	Z	0.514	0.514	3	4	Active
87	M20	Z	0.514	0.514	4	5	Active
88	M20	Z	0.514	0.514	5	6	Active
89	M20	Z	0.514	0.5	6	7	Active
90	M20	Z	0.5	0.46	7	8	Active

Member Distributed Loads (BLC 19 : BLC 8 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
91	M20	Z	0.46	0.406	8	9	Active
92	M20	Z	0.406	0.352	9	10	Active
93	M20	Z	0.352	0.298	10	11	Active
94	M20	Z	0.298	0.244	11	12	Active
95	M20	Z	0.244	0.19	12	13	Active
96	M20	Z	0.19	0.136	13	14	Active
97	M20	Z	0.136	0.082	14	15	Active
98	M20	Z	0.082	0.028	15	16	Active
99	M21	Z	0.27	0.27	1.665e-15	1	Active
100	M21	Z	0.27	0.27	1	2	Active
101	M21	Z	0.27	0.27	2	3	Active
102	M21	Z	0.27	0.27	3	4	Active
103	M21	Z	0.27	0.27	4	5	Active
104	M21	Z	0.27	0.27	5	6	Active
105	M21	Z	0.27	0.257	6	7	Active
106	M21	Z	0.257	0.23	7	8	Active
107	M21	Z	0.23	0.203	8	9	Active
108	M21	Z	0.203	0.176	9	10	Active
109	M21	Z	0.176	0.149	10	11	Active
110	M21	Z	0.149	0.122	11	12	Active
111	M21	Z	0.122	0.095	12	13	Active
112	M21	Z	0.095	0.068	13	14	Active
113	M21	Z	0.068	0.041	14	15	Active
114	M21	Z	0.041	0.014	15	16	Active
115	M44	Z	0.243	0.243	4.441e-16	1	Active
116	M44	Z	0.243	0.243	1	2	Active
117	M44	Z	0.243	0.243	2	3	Active
118	M44	Z	0.243	0.243	3	4	Active
119	M44	Z	0.243	0.243	4	5	Active
120	M44	Z	0.243	0.243	5	6	Active
121	M44	Z	0.243	0.243	6	7	Active
122	M44	Z	0.243	0.23	7	8	Active
123	M44	Z	0.23	0.203	8	9	Active
124	M44	Z	0.203	0.176	9	10	Active
125	M44	Z	0.176	0.149	10	11	Active
126	M44	Z	0.149	0.122	11	12	Active
127	M44	Z	0.122	0.095	12	13	Active
128	M44	Z	0.095	0.068	13	14	Active
129	M44	Z	0.068	0.041	14	15	Active
130	M44	Z	0.041	0.014	15	16	Active
131	M102	Z	0.014	0.041	1	2	Active
132	M102	Z	0.041	0.068	2	3	Active
133	M102	Z	0.068	0.095	3	4	Active
134	M102	Z	0.095	0.122	4	5	Active
135	M102	Z	0.122	0.149	5	6	Active
136	M102	Z	0.149	0.176	6	7	Active
137	M102	Z	0.176	0.203	7	8	Active
138	M102	Z	0.203	0.23	8	9	Active
139	M102	Z	0.23	0.244	9	10	Active
140	M102	Z	0.244	0.23	10	11	Active
141	M102	Z	0.23	0.203	11	12	Active
142	M102	Z	0.203	0.176	12	13	Active
143	M102	Z	0.176	0.149	13	14	Active
144	M102	Z	0.149	0.122	14	15	Active
145	M102	Z	0.122	0.095	15	16	Active
146	M102	Z	0.095	0.068	16	17	Active
147	M102	Z	0.068	0.041	17	18	Active
148	M102	Z	0.041	0.014	18	19	Active

Member Distributed Loads (BLC 19 : BLC 8 Transient Area Loads) (Continued)

	Member Label	Direction	Start Magnitud…	End Magnitude…	Start Location […	End Location [(…	Inactive [(k, k-f…
149	M103	Z	0.014	0.041	1	2	Active
150	M103	Z	0.041	0.068	2	3	Active
151	M103	Z	0.068	0.095	3	4	Active
152	M103	Z	0.095	0.122	4	5	Active
153	M103	Z	0.122	0.149	5	6	Active
154	M103	Z	0.149	0.176	6	7	Active
155	M103	Z	0.176	0.203	7	8	Active
156	M103	Z	0.203	0.217	8	9	Active
157	M103	Z	0.217	0.203	9	10	Active
158	M103	Z	0.203	0.176	10	11	Active
159	M103	Z	0.176	0.149	11	12	Active
160	M103	Z	0.149	0.122	12	13	Active
161	M103	Z	0.122	0.095	13	14	Active
162	M103	Z	0.095	0.068	14	15	Active
163	M103	Z	0.068	0.041	15	16	Active
164	M103	Z	0.041	0.014	16	17	Active

Load Combinations

	De…	So…	PD…	SR…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…
1	De…	Yes	Y		DL	1																		
2	De…	Yes	Y		LL	1																		
3	De…	Yes	Y		DL	1	LL	1																
4	IB…	Yes	Y		DL	1.4																		
5	IB…	Yes	Y		DL	1.2	LL	1.6	LLS	1.6	RLL	0.5												
6	IB…	Yes	Y		DL	1.2	LL	1.6	LLS	1.6														
7	IB…	Yes	Y		DL	1.2	RLL	1.6	LL	0.5	LLS	1												
8	IB…	Yes	Y		DL	1.2	RLL	1.6	WLX	0.5	W…	0.5												
9	IB…	Yes	Y		DL	1.2	RLL	1.6	W…	0.5	W…	0.5												
10	IB…	Yes	Y		DL	1.2	RLL	1.6	W…	0.5	W…	0.5												
11	IB…	Yes	Y		DL	1.2	RLL	1.6	WLZ	0.5	W…	0.5												
12	IB…	Yes	Y		DL	1.2	RLL	1.6	W…	0.5	W…	0.5												
13	IB…	Yes	Y		DL	1.2	RLL	1.6	W…	0.5	W…	0.5												
14	IB…	Yes	Y		DL	1.2	WLX	0.5	W…	0.5														
15	IB…	Yes	Y		DL	1.2	W…	0.5	W…	0.5														
16	IB…	Yes	Y		DL	1.2	W…	0.5	W…	0.5														
17	IB…	Yes	Y		DL	1.2	WLZ	0.5	W…	0.5														
18	IB…	Yes	Y		DL	1.2	W…	0.5	W…	0.5														
19	IB…	Yes	Y		DL	1.2	W…	0.5	W…	0.5														
20	IB…	Yes	Y		DL	1.2	WLX	1	LL	0.5	LLS	1	RLL	0.5	W…	1								
21	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	RLL	0.5	W…	1								
22	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	RLL	0.5	W…	1								
23	IB…	Yes	Y		DL	1.2	WLZ	1	LL	0.5	LLS	1	RLL	0.5	W…	1								
24	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	RLL	0.5	W…	1								
25	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	RLL	0.5	W…	1								
26	IB…	Yes	Y		DL	1.2	WLX	1	LL	0.5	LLS	1	W…	1										
27	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	W…	1										
28	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	W…	1										
29	IB…	Yes	Y		DL	1.2	WLZ	1	LL	0.5	LLS	1	W…	1										
30	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	W…	1										
31	IB…	Yes	Y		DL	1.2	W…	1	LL	0.5	LLS	1	W…	1										
32	IB…	Yes	Y		DL	0.9	WLX	1	W…	1														
33	IB…	Yes	Y		DL	0.9	W…	1	W…	1														
34	IB…	Yes	Y		DL	0.9	W…	1	W…	1														
35	IB…	Yes	Y		DL	0.9	WLZ	1	W…	1														
36	IB…	Yes	Y		DL	0.9	W…	1	W…	1														
37	IB…	Yes	Y		DL	0.9	W…	1	W…	1														
38	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
39	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								

Load Combinations (Continued)

	De…	So…	PD…	SR…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…	BLC	Fa…
40	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
41	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
42	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
43	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	0.3	LL	0.5	LLS	1								
44	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
45	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
46	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
47	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
48	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
49	IB…	Yes	Y		DL	1.2	Sd…	0.2	Rh…	1	Rh…	-0.3	LL	0.5	LLS	1								
50	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
51	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
52	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
53	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
54	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
55	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	0.3												
56	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												
57	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												
58	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												
59	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												
60	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												
61	IB…	Yes	Y		DL	0.9	Sd…	-0.2	Rh…	1	Rh…	-0.3												

Node Reactions

	Node…		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
1	N88	max	2.927	32	28.006	11	0.152	58	2.642	46	0.005	44	14.842	38
2		min	-1.664	50	0	2	-2.18	23	-8.82	41	-0.007	20	-22.666	20
3	N41	max	2.702	20	3.202	20	0.165	44	2.643	46	0.005	44	15.674	38
4		min	-1.889	38	-0.129	50	-4.529	23	-13.382	23	-0.007	20	-22.595	20
5	N40	max	3.003	32	20.044	8	0.157	56	2.666	44	0.005	44	8.472	38
6		min	-0.502	50	0	2	-2.352	23	-8.82	47	-0.007	20	-18.295	20
7	N5	max	1.311	32	19.84	13	2.187	35	6.522	35	0.005	44	9.081	44
8		min	-0.533	56	0	2	-0.519	53	-8.82	41	-0.007	20	-14.59	20
9	N3	max	2.897	20	2.835	44	4.546	35	13.436	35	0.005	44	16.813	44
10		min	-2.017	44	0	2	-0.545	47	-8.814	41	-0.007	20	-24.148	20
11	N1	max	4.771	26	28.896	8	2.361	35	6.929	29	0.005	44	15.516	44
12		min	-1.737	56	0	2	-0.507	53	-8.82	47	-0.007	20	-28.313	20
13	N58	max	2.447	32	47.255	8	0.27	58	4.673	46	0.009	44	16.022	44
14		min	-0.93	56	0	2	-0.902	53	-15.6	41	-0.013	20	-26.206	20
15	N9	max	4.103	20	3.767	44	0.293	46	4.688	46	0.009	44	26.973	44
16		min	-3.061	44	-1.69	32	-0.974	47	-15.597	41	-0.013	20	-37.166	20
17	N8	max	8.504	26	43.342	8	2.249	11	14.583	44	0.009	44	25.891	44
18		min	-2.818	50	0	2	-2.531	59	-23.92	59	-0.013	20	-49.624	20
19	N89	max	6.003	32	41.482	8	0.353	56	5.048	56	0.009	44	15.959	44
20		min	-0.937	56	0	2	-4.295	47	-33.768	47	-0.013	20	-35.998	20
21	N44	max	4.401	20	4.806	20	0.297	44	4.691	46	0.009	44	26.018	44
22		min	-2.911	56	-1.539	56	-0.975	41	-15.598	41	-0.013	20	-38.876	20
23	N60	max	5.194	32	41.857	11	2.255	8	14.5	46	0.009	44	26.833	44
24		min	-2.943	38	0	2	-2.53	59	-23.915	53	-0.013	20	-40.843	20
25	N62	max	2.436	32	41.477	13	0.343	58	4.971	58	0.009	44	15.894	44
26		min	-0.933	56	0	2	-4.295	41	-33.767	41	-0.013	20	-26.084	20
27	N13	max	4.068	20	3.752	44	0.293	46	4.688	46	0.009	44	26.751	44
28		min	-3.036	44	-1.668	32	-0.974	47	-15.597	41	-0.013	20	-36.846	20
29	N12	max	8.467	26	43.33	8	2.249	11	14.583	44	0.009	44	25.652	44
30		min	-2.793	50	0	2	-2.531	59	-23.92	59	-0.013	20	-49.28	20
31	N91	max	5.991	32	41.482	8	0.353	56	5.048	56	0.009	44	15.822	44
32		min	-0.929	56	0	2	-4.295	47	-33.768	47	-0.013	20	-35.801	20
33	N46	max	4.364	20	4.777	20	0.297	44	4.691	46	0.009	44	25.79	44

Node Reactions (Continued)

	Node...		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
34		min	-2.886	56	-1.52	50	-0.975	41	-15.598	41	-0.013	20	-38.546	20
35	N64	max	5.159	32	41.857	11	2.255	8	14.5	46	0.009	44	26.605	44
36		min	-2.919	38	0	2	-2.53	59	-23.915	53	-0.013	20	-40.514	20
37	N66	max	2.425	32	41.477	13	0.343	58	4.971	58	0.009	44	15.757	44
38		min	-0.926	56	0	2	-4.295	41	-33.767	41	-0.013	20	-25.886	20
39	N17	max	4.031	20	3.734	44	0.293	46	4.688	46	0.009	44	26.526	44
40		min	-3.011	44	-1.643	32	-0.974	47	-15.597	41	-0.013	20	-36.522	20
41	N16	max	8.432	26	43.317	8	2.249	11	14.583	44	0.009	44	25.426	44
42		min	-2.769	50	0	2	-2.531	59	-23.92	59	-0.013	20	-48.956	20
43	N93	max	5.98	32	41.482	8	0.353	56	5.048	56	0.009	44	15.685	44
44		min	-0.921	56	0	2	-4.295	47	-33.768	47	-0.013	20	-35.603	20
45	N48	max	4.327	20	4.747	20	0.297	44	4.691	46	0.009	44	25.562	44
46		min	-2.862	50	-1.5	50	-0.974	41	-15.598	41	-0.013	20	-38.217	20
47	N68	max	5.123	32	41.857	11	2.255	8	14.5	46	0.009	44	26.377	44
48		min	-2.895	38	0	2	-2.53	59	-23.915	53	-0.013	20	-40.184	20
49	N70	max	2.414	32	41.477	13	0.343	58	4.971	58	0.009	44	15.62	44
50		min	-0.918	56	0	2	-4.295	41	-33.766	41	-0.013	20	-25.688	20
51	N21	max	3.994	20	3.716	44	0.293	46	4.688	46	0.009	44	26.301	44
52		min	-2.986	44	-1.618	32	-0.974	47	-15.597	41	-0.013	20	-36.196	20
53	N20	max	8.398	26	43.303	8	2.249	11	14.583	44	0.009	44	25.202	44
54		min	-2.746	50	0	2	-2.531	59	-23.92	59	-0.013	20	-48.631	20
55	N95	max	5.969	32	41.482	8	0.353	56	5.048	56	0.009	44	15.548	44
56		min	-0.914	56	0	2	-4.295	47	-33.768	47	-0.013	20	-35.406	20
57	N50	max	4.29	20	4.717	20	0.297	44	4.691	46	0.009	44	25.339	38
58		min	-2.838	50	-1.481	50	-0.974	41	-15.598	41	-0.013	20	-37.887	20
59	N72	max	5.087	32	41.857	11	2.255	8	14.5	46	0.009	44	26.155	38
60		min	-2.871	38	0	2	-2.53	59	-23.915	53	-0.013	20	-39.855	20
61	N74	max	2.402	32	41.477	13	0.343	58	4.971	58	0.009	44	15.484	38
62		min	-0.91	56	0	2	-4.295	41	-33.766	41	-0.013	20	-25.49	20
63	N25	max	3.957	20	3.698	44	0.293	46	4.688	46	0.009	44	26.076	44
64		min	-2.961	44	-1.592	32	-0.974	47	-15.597	41	-0.013	20	-35.871	20
65	N24	max	8.364	26	43.29	8	2.249	11	14.583	44	0.009	44	24.977	44
66		min	-2.723	50	0	2	-2.531	59	-23.92	59	-0.013	20	-48.306	20
67	N97	max	5.958	32	41.482	8	0.353	56	5.048	56	0.009	44	15.414	38
68		min	-0.906	56	0	2	-4.295	47	-33.768	47	-0.013	20	-35.208	20
69	N52	max	4.253	20	4.688	20	0.297	44	4.691	46	0.009	44	25.117	38
70		min	-2.814	50	-1.462	50	-0.974	41	-15.598	41	-0.013	20	-37.558	20
71	N76	max	5.052	32	41.857	11	2.255	8	14.5	46	0.009	44	25.933	38
72		min	-2.847	38	0	2	-2.53	59	-23.915	53	-0.013	20	-39.526	20
73	N78	max	2.391	32	41.477	13	0.343	58	4.971	58	0.009	44	15.351	38
74		min	-0.902	56	0	2	-4.295	41	-33.766	41	-0.013	20	-25.292	20
75	N29	max	3.921	20	3.68	44	0.293	46	4.688	46	0.009	44	25.855	38
76		min	-2.936	44	-1.567	32	-0.974	47	-15.597	41	-0.013	20	-35.545	20
77	N28	max	8.329	26	43.276	8	2.249	11	14.583	44	0.009	44	24.756	38
78		min	-2.7	50	0	2	-2.531	59	-23.92	59	-0.013	20	-47.98	20
79	N99	max	5.946	32	41.482	8	0.353	56	5.048	56	0.009	44	15.281	38
80		min	-0.898	56	0	2	-4.295	47	-33.768	47	-0.013	20	-35.01	20
81	N54	max	4.216	20	4.658	20	0.297	44	4.691	46	0.009	44	24.895	38
82		min	-2.79	50	-1.443	50	-0.974	41	-15.598	41	-0.013	20	-37.228	20
83	N80	max	5.016	32	41.857	11	2.255	8	14.5	46	0.009	44	25.711	38
84		min	-2.823	38	0	2	-2.53	59	-23.915	53	-0.013	20	-39.197	20
85	N82	max	2.38	32	41.477	13	0.343	58	4.971	58	0.009	44	15.218	38
86		min	-0.895	56	0	2	-4.295	41	-33.766	41	-0.013	20	-25.095	20
87	N33	max	3.884	20	3.662	38	0.293	46	4.688	46	0.009	44	25.636	38
88		min	-2.912	38	-1.542	32	-0.974	47	-15.597	41	-0.013	20	-35.22	20
89	N32	max	8.295	26	43.262	8	2.249	11	14.583	44	0.009	44	24.537	38
90		min	-2.677	50	0	2	-2.531	59	-23.92	59	-0.013	20	-47.655	20
91	N101	max	5.935	32	41.482	8	0.353	56	5.048	56	0.009	44	15.148	38

Node Reactions (Continued)

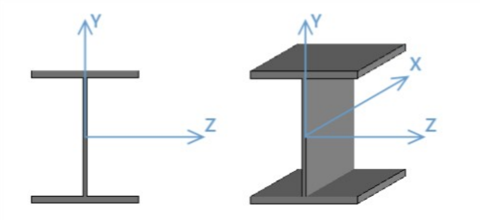
	Node…		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
92		min	-0.89	56	0	2	-4.295	47	-33.768	47	-0.013	20	-34.811	20
93	N56	max	4.179	20	4.628	20	0.296	44	4.691	46	0.009	44	24.673	38
94		min	-2.766	50	-1.424	50	-0.974	41	-15.598	41	-0.013	20	-36.899	20
95	N84	max	4.98	32	41.857	11	2.255	8	14.5	46	0.009	44	25.489	38
96		min	-2.799	38	0	2	-2.53	59	-23.915	53	-0.013	20	-38.868	20
97	N86	max	2.37	32	41.477	13	0.343	58	4.971	58	0.009	44	15.087	38
98		min	-0.887	56	0	2	-4.295	41	-33.766	41	-0.013	20	-24.902	20
99	N37	max	3.849	20	3.649	38	0.291	46	4.675	46	0.009	44	25.434	38
100		min	-2.891	38	-1.527	32	-0.972	47	-15.589	41	-0.013	20	-34.901	20
101	N36	max	8.325	26	49.033	8	0.275	56	4.715	44	0.009	44	24.333	38
102		min	-2.646	50	0	2	-0.903	53	-15.601	47	-0.013	20	-47.134	20
103	Totals:	max	242.209	20	1382.7…	8	31.965	58						
104		min	-106.551	38	0	2	-106.55	53						

Material Take-Off

	Material	Size	Pieces	Length [ft]	Weight [k]
1	Hot Rolled Steel				
2	A500 Gr.B Rect	HSS8X8X4	6	96	2.494
3	A500 Gr.B Rect	HSS8X8X8	45	720	35.573
4	A992	W10X39	19	362	14.166
5	A992	W16X36	14	336	12.119
6	A992	W24X76	2	66	5.031
7	A992	W27X114	16	672	76.832
8	Total HR Steel		102	2252	146.215

Detail Report: M52

Load Combination: Envelope



Input Data:

Shape:	W10X39	I Node:	N2
Member Type:	Beam	J Node:	N4
Length (ft):	20	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	9.92	Area (in^2):	11.5	S_w (in^4):	19.9
b_f (in):	7.99	Z_{yy} (in^3):	17.2	r_T (in):	2.16
t_f (in):	0.53	Z_{zz} (in^3):	46.8	J (in^4):	0.976
t_w (in):	0.315	C_w (in^6):	992	k_{det} (in):	1.188
I_{yy} (in^4):	45	W_{no} (in^2):	18.8	k_{des} (in):	1.03
I_{zz} (in^4):	209				

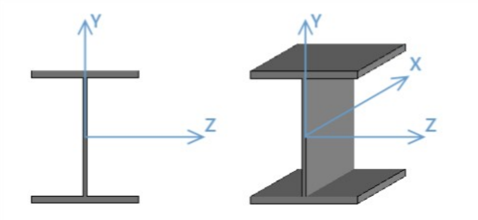
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	20	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/4299
$L_{b\ z\text{-}z}$ (ft):	20	$K_{z\text{-}z}$:	1	Max Defl Location:	5.714
$L_{comp\ top}$ (ft):	20	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	20	z sway:	No		
L_{torque} (ft):	20	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	20	-	-	-	-
Applied Loading - Shear	20	-	-	-	-
Axial Tension Analysis	20	0.000 k	517.5 k	-	-
Axial Compression Analysis	20	0.000 k	176.494 k	-	-
Flexural Analysis (Strong Axis)	20	17.364 k-ft	175.5 k-ft	-	-
Flexural Analysis (Weak Axis)	20	0.002 k-ft	64.5 k-ft	-	-
Shear Analysis (Major Axis y)	20	1.959 k	93.744 k	0.021	Pass
Shear Analysis (Minor Axis z)	20	0.000 k	228.674 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	20	-	-	0.099	Pass

Detail Report: M53 **Load Combination:** Envelope



Input Data:

Shape:	W10X39	I Node:	N4
Member Type:	Beam	J Node:	N6
Length (ft):	18	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5\circ}F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	9.92	Area (in^2):	11.5	S_w (in^4):	19.9
b_f (in):	7.99	Z_{yy} (in^3):	17.2	r_T (in):	2.16
t_f (in):	0.53	Z_{zz} (in^3):	46.8	J (in^4):	0.976
t_w (in):	0.315	C_w (in^6):	992	k_{det} (in):	1.188
I_{yy} (in^4):	45	W_{no} (in^2):	18.8	k_{des} (in):	1.03
I_{zz} (in^4):	209				

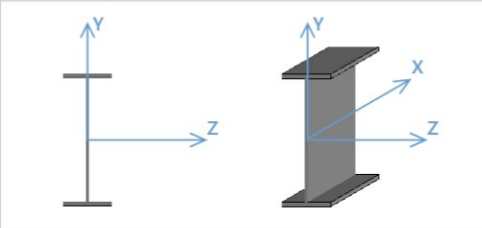
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	18	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/4268
$L_{b\ z\text{-}z}$ (ft):	18	$K_{z\text{-}z}$:	1	Max Defl Location:	6.98
$L_{comp\ top}$ (ft):	18	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	18	z sway:	No		
L_{torque} (ft):	18	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	23	-	-	-	-
Applied Loading - Shear	20	-	-	-	-
Axial Tension Analysis	23	0.000 k	517.5 k	-	-
Axial Compression Analysis	23	0.000 k	216.419 k	-	-
Flexural Analysis (Strong Axis)	23	2.403 k-ft	175.5 k-ft	-	-
Flexural Analysis (Weak Axis)	23	5.61 k-ft	64.5 k-ft	-	-
Shear Analysis (Major Axis y)	20	0.968 k	93.744 k	0.01	Pass
Shear Analysis (Minor Axis z)	20	0.005 k	228.674 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	23	-	-	0.101	Pass

Detail Report: M54 **Load Combination:** Envelope



Input Data:

Shape:	W27X114	I Node:	N2
Member Type:	Beam	J Node:	N10
Length (ft):	42	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	27.3	Area (in^2):	33.6	S_w (in^4):	156
b_f (in):	10.1	Z_{yy} (in^3):	49.3	r_T (in):	2.58
t_f (in):	0.93	Z_{zz} (in^3):	343	J (in^4):	7.33
t_w (in):	0.57	C_w (in^6):	27600	k_{det} (in):	2.125
I_{yy} (in^4):	159	W_{no} (in^2):	66.6	k_{des} (in):	1.53
I_{zz} (in^4):	4080				

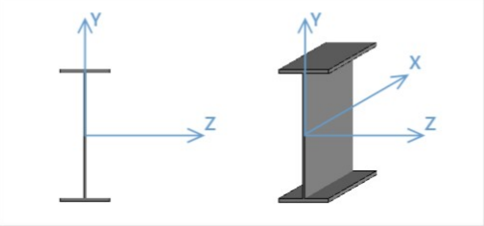
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	42	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/525
$L_{b\ z\text{-}z}$ (ft):	42	$K_{z\text{-}z}$:	1	Max Defl Location:	21
$L_{comp\ top}$ (ft):	42	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	42	z sway:	No		
L_{torque} (ft):	42	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	8	-	-	-	-
Applied Loading - Shear	8	-	-	-	-
Axial Tension Analysis	8	0.000 k	1512 k	-	-
Axial Compression Analysis	8	0.000 k	141.409 k	-	-
Flexural Analysis (Strong Axis)	8	286.033 k-ft	383.256 k-ft	-	-
Flexural Analysis (Weak Axis)	8	31.677 k-ft	184.875 k-ft	-	-
Shear Analysis (Major Axis y)	8	27.302 k	466.83 k	0.058	Pass
Shear Analysis (Minor Axis z)	8	2.352 k	507.222 k	0.005	Pass
Bending & Axial Interaction Check (UC Bending Max)	8	-	-	0.918	Pass

Detail Report: M55 **Load Combination:** Envelope



Input Data:

Shape:	W24X76	I Node:	N6
Member Type:	Beam	J Node:	N57
Length (ft):	33	I Release:	BenPIN
Material Type:	Hot Rolled Steel	J Release:	BenPIN
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	23.9	Area (in^2):	22.4	S_w (in^4):	79.8
b_f (in):	8.99	Z_{yy} (in^3):	28.6	r_T (in):	2.29
t_f (in):	0.68	Z_{zz} (in^3):	200	J (in^4):	2.68
t_w (in):	0.44	C_w (in^6):	11100	k_{det} (in):	1.938
I_{yy} (in^4):	82.5	W_{no} (in^2):	52.2	k_{des} (in):	1.18
I_{zz} (in^4):	2100				

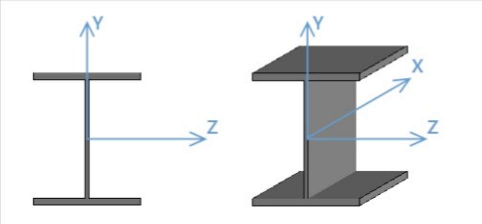
Design Properties:

$L_{b\ y-y}$ (ft):	33	K_{y-y}:	1	Max Defl Ratio:	L/625
$L_{b\ z-z}$ (ft):	33	K_{z-z}:	1	Max Defl Location:	16.5
$L_{comp\ top}$ (ft):	33	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	33	z sway:	No		
L_{torque} (ft):	33	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	8	-	-	-	-
Applied Loading - Shear	8	-	-	-	-
Axial Tension Analysis	8	0.000 k	1008 k	-	-
Axial Compression Analysis	8	0.000 k	118.851 k	-	-
Flexural Analysis (Strong Axis)	8	157.288 k-ft	234.212 k-ft	-	-
Flexural Analysis (Weak Axis)	8	4.099 k-ft	107.25 k-ft	-	-
Shear Analysis (Major Axis y)	8	19.076 k	315.48 k	0.06	Pass
Shear Analysis (Minor Axis z)	8	0.391 k	330.113 k	0.001	Pass
Bending & Axial Interaction Check (UC Bending Max)	8	-	-	0.71	Pass

Detail Report: M56 **Load Combination:** Envelope



Input Data:

Shape:	W10X39	I Node:	N10
Member Type:	Beam	J Node:	N7
Length (ft):	20	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5\circ}F^{-1}$):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	9.92	Area (in^2):	11.5	S_w (in^4):	19.9
b_f (in):	7.99	Z_{yy} (in^3):	17.2	r_T (in):	2.16
t_f (in):	0.53	Z_{zz} (in^3):	46.8	J (in^4):	0.976
t_w (in):	0.315	C_w (in^6):	992	k_{det} (in):	1.188
I_{yy} (in^4):	45	W_{no} (in^2):	18.8	k_{des} (in):	1.03
I_{zz} (in^4):	209				

Design Properties:

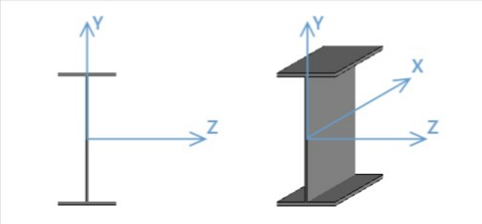
$L_{b\ y\text{-}y}$ (ft):	20	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/2596
$L_{b\ z\text{-}z}$ (ft):	20	$K_{z\text{-}z}$:	1	Max Defl Location:	14.898
$L_{comp\ top}$ (ft):	20	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft):	20	z sway:	No		
L_{torque} (ft):	20	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	20	-	-	-	-
Applied Loading - Shear	20	-	-	-	-
Axial Tension Analysis	20	0.000 k	517.5 k	-	-
Axial Compression Analysis	20	0.000 k	176.494 k	-	-
Flexural Analysis (Strong Axis)	20	28.305 k-ft	175.5 k-ft	-	-
Flexural Analysis (Weak Axis)	20	0.211 k-ft	64.5 k-ft	-	-
Shear Analysis (Major Axis y)	20	3.314 k	93.744 k	0.035	Pass
Shear Analysis (Minor Axis z)	20	0.527 k	228.674 k	0.002	Pass
Bending & Axial Interaction Check (UC Bending Max)	20	-	-	0.165	Pass

Detail Report: M57

Load Combination: Envelope



Input Data:

Shape:	W16X36	I Node:	N10
Member Type:	Beam	J Node:	N90
Length (ft):	24	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A992	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.1
E (ksi):	29000	Density (k/ft^3):	0.49	F_u (ksi):	65
G (ksi):	11154	F_y (ksi):	50	R_t:	1.1
Nu:	0.3				

Shape Properties:

d (in):	15.9	Area (in^2):	10.6	S_w (in^4):	20.3
b_f (in):	6.99	Z_{yy} (in^3):	10.8	r_T (in):	1.79
t_f (in):	0.43	Z_{zz} (in^3):	64	J (in^4):	0.545
t_w (in):	0.295	C_w (in^6):	1460	k_{det} (in):	1.125
I_{yy} (in^4):	24.5	W_{no} (in^2):	27	k_{des} (in):	0.832
I_{zz} (in^4):	448				

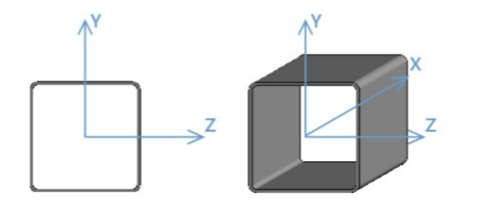
Design Properties:

$L_{b\ y-y}$ (ft) :	24	K_{y-y}:	1	Max Defl Ratio:	L/568
$L_{b\ z-z}$ (ft) :	24	K_{z-z}:	1	Max Defl Location:	12
$L_{comp\ top}$ (ft) :	24	y sway:	No	Span:	1
$L_{comp\ bot}$ (ft) :	24	z sway:	No		
L_{torque} (ft) :	24	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	8	-	-	-	-
Applied Loading - Shear	8	-	-	-	-
Axial Tension Analysis	8	0.000 k	477 k	-	-
Axial Compression Analysis	8	0.000 k	66.73 k	-	-
Flexural Analysis (Strong Axis)	8	55.628 k-ft	87.789 k-ft	-	-
Flexural Analysis (Weak Axis)	8	2.315 k-ft	40.5 k-ft	-	-
Shear Analysis (Major Axis y)	8	13.292 k	140.715 k	0.094	Pass
Shear Analysis (Minor Axis z)	8	0.778 k	162.308 k	0.005	Pass
Bending & Axial Interaction Check (UC Bending Max)	8	-	-	0.691	Pass

Detail Report: M1 **Load Combination:** Envelope



Input Data:

Shape:	HSS8X8X4	I Node:	N1
Member Type:	Column	J Node:	N2
Length (ft):	16	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5\circ}F^{-1}$):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	I_{yy} (in^4):	70.7	Area (in^2):	7.1
b_f (in):	8	I_{zz} (in^4):	70.7	J (in^4):	111
t (in):	0.233				

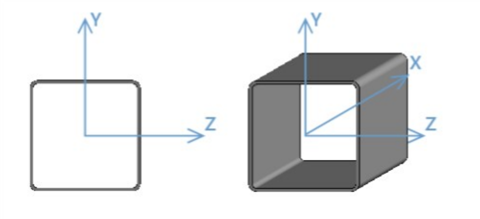
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	16	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/161
$L_{b\ z\text{-}z}$ (ft):	16	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	16	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	16	z sway:	No		
L_{torque} (ft):	16	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	20	-	-	-	-
Applied Loading - Shear	20	-	-	-	-
Axial Tension Analysis	20	0.000 k	293.94 k	-	-
Axial Compression Analysis	20	20.921 k	229.143 k	-	-
Flexural Analysis (Strong Axis)	20	28.313 k-ft	66.288 k-ft	-	-
Flexural Analysis (Weak Axis)		0.034 k-ft	66.288 k-ft	-	-
Shear Analysis (Major Axis y)	20	4.9 k	84.512 k	0.058	Pass
Shear Analysis (Minor Axis z)	20	0.012 k	84.512 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	20	-	-	0.473	Pass
Torsional Analysis		-	58.091 k-ft	-	-

Detail Report: M2 **Load Combination:** Envelope



Input Data:

Shape:	HSS8X8X4	I Node:	N3
Member Type:	Column	J Node:	N4
Length (ft):	16	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5}$°F^{-1}):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	I_{yy} (in^4):	70.7	Area (in^2):	7.1
b_f (in):	8	I_{zz} (in^4):	70.7	J (in^4):	111
t (in):	0.233				

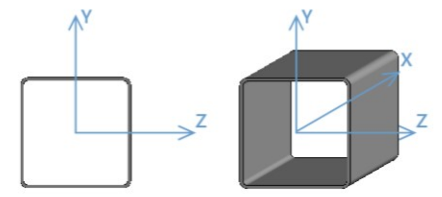
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	16	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/161
$L_{b\ z\text{-}z}$ (ft):	16	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	16	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	16	z sway:	No		
L_{torque} (ft):	16	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	20	-	-	-	-
Applied Loading - Shear	29	-	-	-	-
Axial Tension Analysis	20	0.000 k	293.94 k	-	-
Axial Compression Analysis	20	0.445 k	229.143 k	-	-
Flexural Analysis (Strong Axis)	20	24.148 k-ft	66.288 k-ft	-	-
Flexural Analysis (Weak Axis)		0.000 k-ft	66.288 k-ft	-	-
Shear Analysis (Major Axis y)	29	0.01 k	84.512 k	0.000	Pass
Shear Analysis (Minor Axis z)	29	4.546 k	84.512 k	0.054	Pass
Bending & Axial Interaction Check (UC Bending Max)	20	-	-	0.365	Pass
Torsional Analysis		-	58.091 k-ft	-	-

Detail Report: M3 **Load Combination:** Envelope



Input Data:

Shape:	HSS8X8X4	I Node:	N5
Member Type:	Column	J Node:	N6
Length (ft):	16	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5\circ}F^{-1}$):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	I_{yy} (in^4):	70.7	Area (in^2):	7.1
b_f (in):	8	I_{zz} (in^4):	70.7	J (in^4):	111
t (in):	0.233				

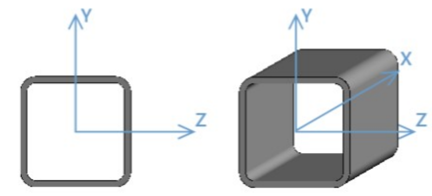
Design Properties:

$L_{b\ y-y}$ (ft):	16	K_{y-y}:	1	Max Defl Ratio:	L/161
$L_{b\ z-z}$ (ft):	16	K_{z-z}:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	16	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	16	z sway:	No		
L_{torque} (ft):	16	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	20	-	-	-	-
Applied Loading - Shear	29	-	-	-	-
Axial Tension Analysis	20	0.000 k	293.94 k	-	-
Axial Compression Analysis	20	12.546 k	229.143 k	-	-
Flexural Analysis (Strong Axis)	20	14.59 k-ft	66.288 k-ft	-	-
Flexural Analysis (Weak Axis)		0.03 k-ft	66.288 k-ft	-	-
Shear Analysis (Major Axis y)	29	0.000 k	84.512 k	0.000	Pass
Shear Analysis (Minor Axis z)	29	2.188 k	84.512 k	0.026	Pass
Bending & Axial Interaction Check (UC Bending Max)	20	-	-	0.248	Pass
Torsional Analysis		-	58.091 k-ft	-	-

Detail Report: M4 **Load Combination:** Envelope



Input Data:

Shape:	HSS8X8X8	I Node:	N9
Member Type:	Column	J Node:	N7
Length (ft):	16	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5\circ}F^{-1}$):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	I_{yy} (in^4):	125	Area (in^2):	13.5
b_f (in):	8	I_{zz} (in^4):	125	J (in^4):	204
t (in):	0.465				

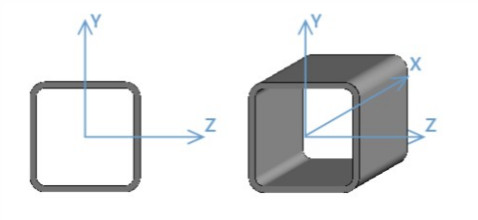
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	16	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/162
$L_{b\ z\text{-}z}$ (ft):	16	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	16	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	16	z sway:	No		
L_{torque} (ft):	16	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	20	-	-	-	-
Applied Loading - Shear	20	-	-	-	-
Axial Tension Analysis	20	1.372 k	558.9 k	-	-
Axial Compression Analysis	20	0.000 k	427.586 k	-	-
Flexural Analysis (Strong Axis)	20	37.166 k-ft	129.375 k-ft	-	-
Flexural Analysis (Weak Axis)		0.009 k-ft	129.375 k-ft	-	-
Shear Analysis (Major Axis y)	20	4.11 k	152.583 k	0.027	Pass
Shear Analysis (Minor Axis z)	20	0.019 k	152.583 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	20	-	-	0.289	Pass
Torsional Analysis		-	108.496 k-ft	-	-

Detail Report: M5 **Load Combination:** Envelope



Input Data:

Shape:	HSS8X8X8	**I Node:**	N8
Member Type:	Column	**J Node:**	N10
Length (ft):	16	**I Release:**	Fixed
Material Type:	Hot Rolled Steel	**J Release:**	Fixed
Design Rule:	Typical	**I Offset (in):**	N/A
Number of Internal Sections:	99	**J Offset (in):**	N/A

Material Properties:

Material:	A500 Gr.B Rect	**Therm. Coeff. ($1e^{5}{}^{\circ}F^{-1}$):**	0.65	**R_y:**	1.4
E (ksi):	29000	**Density (k/ft^3):**	0.527	**F_u (ksi):**	58
G (ksi):	11154	**F_y (ksi):**	46	**R_t:**	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	**I_{yy} (in^4):**	125	**Area (in^2):**	13.5
b_f (in):	8	**I_{zz} (in^4):**	125	**J (in^4):**	204
t (in):	0.465				

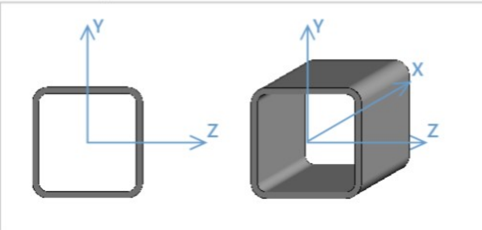
Design Properties:

$L_{b\ y\text{-}y}$ (ft):	16	**$K_{y\text{-}y}$:**	1	**Max Defl Ratio:**	L/162
$L_{b\ z\text{-}z}$ (ft):	16	**$K_{z\text{-}z}$:**	1	**Max Defl Location:**	0
$L_{comp\ top}$ (ft):	16	**y sway:**	No	**Span:**	N/A
$L_{comp\ bot}$ (ft):	16	**z sway:**	No		
L_{torque} (ft):	16	**Function:**	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	20	-	-	-	-
Applied Loading - Shear	20	-	-	-	-
Axial Tension Analysis	20	0.000 k	558.9 k	-	-
Axial Compression Analysis	20	30.933 k	427.586 k	-	-
Flexural Analysis (Strong Axis)	20	49.624 k-ft	129.375 k-ft	-	-
Flexural Analysis (Weak Axis)		7.3 k-ft	129.375 k-ft	-	-
Shear Analysis (Major Axis y)	20	8.7 k	152.583 k	0.057	Pass
Shear Analysis (Minor Axis z)	20	1.403 k	152.583 k	0.009	Pass
Bending & Axial Interaction Check (UC Bending Max)	20	-	-	0.476	Pass
Torsional Analysis		-	108.496 k-ft	-	-

Detail Report: M29 **Load Combination:** Envelope



Input Data:

Shape:	HSS8X8X8	I Node:	N58
Member Type:	Column	J Node:	N57
Length (ft):	16	I Release:	Fixed
Material Type:	Hot Rolled Steel	J Release:	Fixed
Design Rule:	Typical	I Offset (in):	N/A
Number of Internal Sections:	99	J Offset (in):	N/A

Material Properties:

Material:	A500 Gr.B Rect	Therm. Coeff. ($1e^{5\circ}F^{-1}$):	0.65	R_y:	1.4
E (ksi):	29000	Density (k/ft^3):	0.527	F_u (ksi):	58
G (ksi):	11154	F_y (ksi):	46	R_t:	1.3
Nu:	0.3				

Shape Properties:

d (in):	8	I_{yy} (in^4):	125	Area (in^2):	13.5
b_f (in):	8	I_{zz} (in^4):	125	J (in^4):	204
t (in):	0.465				

Design Properties:

$L_{b\ y\text{-}y}$ (ft):	16	$K_{y\text{-}y}$:	1	Max Defl Ratio:	L/162
$L_{b\ z\text{-}z}$ (ft):	16	$K_{z\text{-}z}$:	1	Max Defl Location:	0
$L_{comp\ top}$ (ft):	16	y sway:	No	Span:	N/A
$L_{comp\ bot}$ (ft):	16	z sway:	No		
L_{torque} (ft):	16	Function:	Lateral		
		Seismic DR:	None		

AISC 15th (360-16): LRFD Code Check

Limit State	Gov. LC	Required	Available	Unity Check	Result
Applied Loading - Bending/Axial	20	-	-	-	-
Applied Loading - Shear	20	-	-	-	-
Axial Tension Analysis	20	0.000 k	558.9 k	-	-
Axial Compression Analysis	20	31.58 k	427.586 k	-	-
Flexural Analysis (Strong Axis)	20	26.206 k-ft	129.375 k-ft	-	-
Flexural Analysis (Weak Axis)		0.053 k-ft	129.375 k-ft	-	-
Shear Analysis (Major Axis y)	20	2.596 k	152.583 k	0.017	Pass
Shear Analysis (Minor Axis z)	20	0.021 k	152.583 k	0.000	Pass
Bending & Axial Interaction Check (UC Bending Max)	20	-	-	0.24	Pass
Torsional Analysis		-	108.496 k-ft	-	-

Current Date: 4/20/2021 12:15 PM
Units system: English
File name: E:\Hangar Connections.rcnx

Steel connections

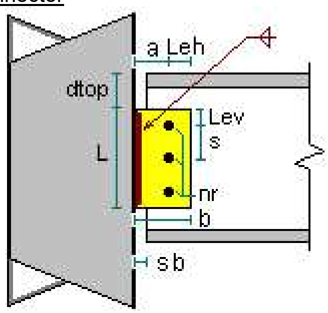
Detailed report

Connection name	**:**	**SP_BCW_1/4PL_4B3/4**
Connection ID	**:**	**1V**

Family: Beam - Column web (BCW)
Type: Single plate

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 24X76
Beam material	:	A992 Gr50
sb: Beam setback	:	0.5 in
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
Horizontal eccentricity	:	0 in

Coped

dct: Top cope depth	:	0 in
ct: Top cope length	:	0 in
dcb: Bottom cope depth	:	0 in
cb: Bottom cope length	:	0 in

Column

General

Support section	:	HSS_SQR 8X8X1_4
Support material	:	A500 GrB rectangular

SINGLE PLATE

Connector

Section	:	PL 1/4x4x21
b: Width	:	4 in
L: Length	:	21 in
tp: Plate thickness	:	0.25 in
Material	:	A36
Plate position on beam	:	Center
Bolts	:	3/4" A325 N
nr: Rows of Bolts	:	7
nc: Bolt columns	:	1
s: Pitch - longitudinal center-to-center spacing	:	3 in
Lev: Vertical edge distance	:	1.5 in

Leh: Horizontal edge distance	:	1.5 in
a: Distance between weld and bolts	:	2.5 in
Hole type on plate	:	Standard (STD)
Hole type on beam	:	Standard (STD)
Welding electrode to support	:	E70XX
D: Weld size to support (1/16 in)	:	3
Wo: Obtuse side weld size (AWS) (1/16 in)	:	3
Wa: Acute side weld size (AWS) (1/16 in)	:	3
Wo: Obtuse side weld size (AISC) (1/16 in)	:	3
Wa: Acute side weld size (AISC) (1/16 in)	:	3

Design code: AISC 360-16 LRFD

DEMANDS

	Beam		Column			
Description	**Ru** [kip]	**Pu** [kip]	**Pu** [kip]	**Mu22** [kip*ft]	**Mu33** [kip*ft]	**Load type**
DL	19.07	0.00	-19.63	14.53	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Thickness	[in]	0.25	--	0.44	✔	p. 10-102
Number of bolts		7	2	12	✔	p 10-102
Distance from the bolt line to the weld line	[in]	2.50	--	3.50	✔	p 10-102
Minimum plate or beam web thickness	[in]	0.25	--	0.31	✔	Table 10-9
Length	[in]	21.00	10.77	21.54	✔	p. 10-104
Thickness, precludes a punching failure of the HSS...	[in]	0.25	--	--	✔	
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-103
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
Beam						
Vertical edge distance	[in]	2.95	1.00	--	✔	Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.50	--	✔	p. 10-103
Support						
Maximum value of the specified yield stress	[Kip/in2]	46.00	--	--	✔	
Yield stress to tensile stress ratio		0.79	--	0.80	✔	Table K2.1A, Table K2.1
Weld size	[1/16in]	3	3	--	✔	p. 10-87
Weld length	[in]	21.00	0.75	--	✔	Sec. J2.2b

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Shear plate						
Bolts shear	[Kip]	112.47	19.07	DL	0.17	Tables (7-1..14)
Bolt bearing under shear load	[Kip]	118.23	19.07	DL	0.16	p. 7-18, Sec. J3.10
Shear yielding	[Kip]	113.40	19.07	DL	0.17	Eq. J4-3
Shear rupture	[Kip]	97.06	19.07	DL	0.20	Eq. J4-4
Block shear	[Kip]	90.53	19.07	DL	0.21	Eq. J4-5
Plate (support side)						
Weld capacity	[Kip]	175.41	19.07	DL	0.11	Tables 8-4 .. 8-11
Beam						
Bolt bearing under shear load	[Kip]	242.59	19.07	DL	0.08	p. 7-18, Sec. J3.10
Shear yielding	[Kip]	315.48	19.07	DL	0.06	Eq. J4-3
Support						
Welds rupture	[Kip/ft]	97.30	7.26	DL	0.07	p. 9-5
Chord wall plastification	[Kip]	23.29	0.00	DL	0.00	Eq. J4-5

Punching shear (shear rupture)	[Kip]	357.58	19.07	DL	**0.05**	p. 10-153
Global critical strength ratio	**0.21**					

NOTES

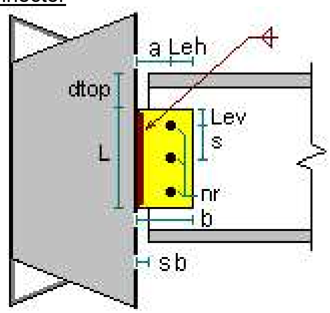
The plate is designed with the conventional configuration criteria.

Connection name : SP BCW
Connection ID : 2V

Family: Beam - Column web (BCW)
Type: Single plate

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 10X39
Beam material	:	A992 Gr50
sb: Beam setback	:	0.5 in
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
Horizontal eccentricity	:	0 in

Coped

dct: Top cope depth	:	0 in
ct: Top cope length	:	0 in
dcb: Bottom cope depth	:	0 in
cb: Bottom cope length	:	0 in

Column

General

Support section	:	HSS_SQR 8X8X1_4
Support material	:	A500 GrB rectangular

SINGLE PLATE

Connector

Section	:	PL 1/4x4x6
b: Width	:	4 in
L: Length	:	6 in
tp: Plate thickness	:	0.25 in
Material	:	A36
Plate position on beam	:	Center
Bolts	:	3/4" A325 N
nr: Rows of Bolts	:	2
nc: Bolt columns	:	1
s: Pitch - longitudinal center-to-center spacing	:	3 in
Lev: Vertical edge distance	:	1.5 in
Leh: Horizontal edge distance	:	1.5 in
a: Distance between weld and bolts	:	2.5 in

Hole type on plate	:	Standard (STD)
Hole type on beam	:	Standard (STD)
Welding electrode to support	:	E70XX
D: Weld size to support (1/16 in)	:	3
Wo: Obtuse side weld size (AWS) (1/16 in)	:	3
Wa: Acute side weld size (AWS) (1/16 in)	:	3
Wo: Obtuse side weld size (AISC) (1/16 in)	:	3
Wa: Acute side weld size (AISC) (1/16 in)	:	3

Design code: AISC 360-16 LRFD

DEMANDS

	Beam		Column			
Description	**Ru** [kip]	**Pu** [kip]	**Pu** [kip]	**Mu22** [kip*ft]	**Mu33** [kip*ft]	**Load type**
DL	0.58	0.00	19.63	14.53	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Thickness	[in]	0.25	--	0.36	✓	p. 10-103
Length	[in]	6.00	3.93	7.86	✓	p. 10-104
Thickness, precludes a punching failure of the HSS...	[in]	0.25	--	--	✓	
Vertical edge distance	[in]	1.50	1.00	--	✓	Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✓	p. 10-103
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✓	Sec. J3.3, Sec. J3.5
Beam						
Vertical edge distance	[in]	3.46	1.00	--	✓	Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.50	--	✓	p. 10-103
Support						
Maximum value of the specified yield stress	[Kip/in2]	46.00	--	--	✓	
Yield stress to tensile stress ratio		0.79	--	0.80	✓	Table K2.1A, Table K2.1
Weld size	[1/16in]	3	3	--	✓	p. 10-87
Weld length	[in]	6.00	0.75	--	✓	Sec. J2.2b

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Shear plate						
Bolts shear	[Kip]	18.08	0.58	DL	0.03	Tables (7-1..14)
Bolt bearing under shear load	[Kip]	17.09	0.58	DL	0.03	p. 7-18, Sec. J3.10
Shear yielding	[Kip]	32.40	0.58	DL	0.02	Eq. J4-3
Shear rupture	[Kip]	27.73	0.58	DL	0.02	Eq. J4-4
Block shear	[Kip]	29.78	0.58	DL	0.02	Eq. J4-5
Flexural rupture	[Kip]	30.59	0.58	DL	0.02	p. 9-10
Plate (support side)						
Weld capacity	[Kip]	50.12	0.58	DL	0.01	Tables 8-4 .. 8-11
Shear yielding/buckling and flexure yielding		1.00	0.00	DL	0.00	Eq. 10-5
Beam						
Bolt bearing under shear load	[Kip]	27.92	0.58	DL	0.02	p. 7-18, Sec. J3.10
Shear yielding	[Kip]	93.74	0.58	DL	0.01	Eq. J4-3
Support						
Welds rupture	[Kip/ft]	97.30	0.78	DL	0.01	p. 9-5
Chord wall plastification	[Kip]	13.63	0.00	DL	0.00	Eq. J4-5
Punching shear (shear rupture)	[Kip]	29.19	0.58	DL	0.02	p. 10-153

Global critical strength ratio **0.03**

NOTES

The plate is designed with the extended configuration criteria.

REFERENCES

[4] AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

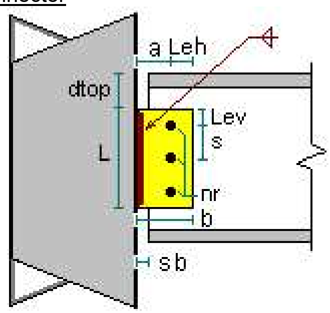
Connection name : SP BCW
Connection ID : 3V

Family: Beam - Column web (BCW)

Type: Single plate

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 24X76
Beam material	:	A992 Gr50
sb: Beam setback	:	0.5 in
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
Horizontal eccentricity	:	0 in

Coped

dct: Top cope depth	:	0 in
ct: Top cope length	:	0 in
dcb: Bottom cope depth	:	0 in
cb: Bottom cope length	:	0 in

Column

General

Support section	:	HSS_SQR 8X8X1_2
Support material	:	A500 GrB rectangular

SINGLE PLATE

Connector

Section	:	PL 1/4x4x21
b: Width	:	4 in
L: Length	:	21 in
tp: Plate thickness	:	0.25 in
Material	:	A36
Plate position on beam	:	Center
Bolts	:	3/4" A325 N
nr: Rows of Bolts	:	7
nc: Bolt columns	:	1
s: Pitch - longitudinal center-to-center spacing	:	3 in
Lev: Vertical edge distance	:	1.5 in
Leh: Horizontal edge distance	:	1.5 in
a: Distance between weld and bolts	:	2.5 in

Hole type on plate	:	Standard (STD)
Hole type on beam	:	Standard (STD)
Welding electrode to support	:	E70XX
D: Weld size to support (1/16 in)	:	3
Wo: Obtuse side weld size (AWS) (1/16 in)	:	3
Wa: Acute side weld size (AWS) (1/16 in)	:	3
Wo: Obtuse side weld size (AISC) (1/16 in)	:	3
Wa: Acute side weld size (AISC) (1/16 in)	:	3

Design code: AISC 360-16 LRFD

DEMANDS

	Beam		Column			
Description	**Ru** [kip]	**Pu** [kip]	**Pu** [kip]	**Mu22** [kip*ft]	**Mu33** [kip*ft]	**Load type**
DL	19.07	0.00	-47.78	88.53	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**	**References**
Shear plate						
Thickness	[in]	0.25	--	0.34	✔	p. 10-103
Length	[in]	21.00	10.77	21.54	✔	p. 10-104
Thickness, precludes a punching failure of the HSS...	[in]	0.25	--	--	✔	
Vertical edge distance	[in]	1.50	1.00	--	✔	Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✔	p. 10-103
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✔	Sec. J3.3, Sec. J3.5
Beam						
Vertical edge distance	[in]	2.95	1.00	--	✔	Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.50	--	✔	p. 10-103
Support						
Maximum value of the specified yield stress	[Kip/in2]	46.00	--	--	✔	
Yield stress to tensile stress ratio		0.79	--	0.80	✔	Table K2.1A, Table K2.1
Weld size	[1/16in]	3	3	--	✔	p. 10-87
Weld length	[in]	21.00	0.75	--	✔	Sec. J2.2b

DESIGN CHECK

Verification	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**	**References**
Shear plate						
Bolts shear	[Kip]	112.47	19.07	DL	0.17	Tables (7-1..14)
Bolt bearing under shear load	[Kip]	118.23	19.07	DL	0.16	p. 7-18, Sec. J3.10
Shear yielding	[Kip]	113.40	19.07	DL	0.17	Eq. J4-3
Shear rupture	[Kip]	97.06	19.07	DL	0.20	Eq. J4-4
Block shear	[Kip]	90.53	19.07	DL	0.21	Eq. J4-5
Flexural rupture	[Kip]	342.56	19.07	DL	0.06	p. 9-10
Plate (support side)						
Weld capacity	[Kip]	175.41	19.07	DL	0.11	Tables 8-4 .. 8-11
Shear yielding/buckling and flexure yielding		1.00	0.03	DL	0.03	Eq. 10-5
Beam						
Bolt bearing under shear load	[Kip]	242.59	19.07	DL	0.08	p. 7-18, Sec. J3.10
Shear yielding	[Kip]	315.48	19.07	DL	0.06	Eq. J4-3
Support						
Welds rupture	[Kip/ft]	194.18	7.26	DL	0.04	p. 9-5
Chord wall plastification	[Kip]	77.20	0.00	DL	0.00	Eq. J4-5
Punching shear (shear rupture)	[Kip]	713.63	19.07	DL	0.03	p. 10-153

Global critical strength ratio **0.21**

NOTES

The plate is designed with the extended configuration criteria.

REFERENCES

[4] AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

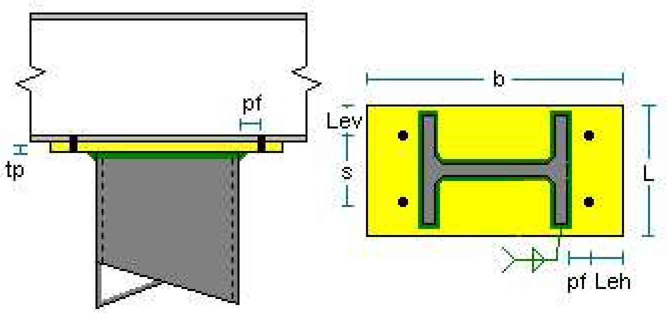
Connection name	**:**	**CP_1PL_2B1**
Connection ID	**:**	**4**

Family: Column cap (CC)

Type: Cap Plate

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 10X39
Beam material	:	A992 Gr50
Built-up	:	No

Column

General

Support section	:	HSS_SQR 8X8X1_4
Support material	:	A500 GrB rectangular
Column orientation	:	Longitudinal

CAP PLATE

Connector

tp: Plate thickness	:	1 in
Plate material	:	A36
Bolts	:	1" A325 N
Lev: Transverse distance to edge	:	1.5 in
Leh: Longitudinal distance to edge	:	2 in
pf: distance bolt centerline-tension flange	:	1.625 in
s: Transverse bolt spacing	:	5.25 in
Hole type on plate	:	Standard (STD)

Beam side

Hole type on beam	:	Standard (STD)

Column side

Weld to support	:	E70XX
D1: Weld size to support (1/16in)	:	5

Stiffeners

Ns: Transverse stiffeners	:	None

Design code: AISC 360-16 LRFD

DEMANDS

Description	Ru [kip]	Pu [kip]	Mu [kip*ft]	PufTop [kip]	PufBot [kip]	Load type
DL	0.00	-1.83	22.40	-34.52	32.69	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Cap Plate						
Bolt diameter	[in]	1.00	--	1.50	✔	DG4 Sec. 1.1
Transverse center-to-center spacing (gage)	[in]	5.25	2.67	12.00	✔	Sec. J3.3, Sec. J3.5
Transverse edge distance	[in]	1.50	1.25	--	✔	Tables J3.4, J3.5
Longitudinal edge distance	[in]	2.00	1.25	--	✔	Tables J3.4, J3.5
Beam						
Transverse edge distance	[in]	1.37	1.25	--	✔	Tables J3.4, J3.5
Plate (support side)						
Distance from centerline of bolt to nearer surface o...	[in]	1.63	1.50	--	✔	DG4 Sec. 2.1
Weld size	[1/16in]	5	2	--	✔	table J2.4

DESIGN CHECK

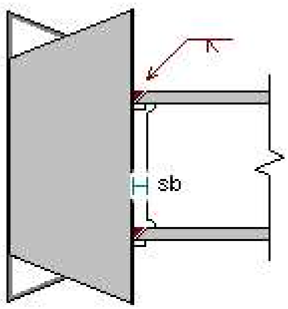
Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Cap Plate						
Resulting tension capacity due prying action	[Kip]	102.79	32.69	DL	**0.32**	p. 9-10
Beam						
Bending	[Kip*ft]	144.23	22.40	DL	**0.16**	Eq. F13-1
Resulting tension capacity due prying action	[Kip]	39.15	32.69	DL	**0.83**	p. 9-12, p. 9-10
Local web yielding	[Kip]	142.35	34.52	DL	**0.24**	DG4 eq. 3.24
Web crippling	[Kip]	104.05	34.52	DL	**0.33**	Eq. J10-4
Compression buckling of the web	[Kip]	103.43	34.52	DL	**0.33**	Eq. J10-8
Support						
Weld capacity	[Kip]	55.68	32.69	DL	**0.59**	Eq. J2-3
Side wall local crippling	[Kip]	138.92	34.52	DL	**0.25**	Eq. J10-4
Side wall local yielding	[Kip]	85.74	34.52	DL	**0.40**	Eq. J4-1
Global critical strength ratio	**0.83**					

Connection name : DW BCW
Connection ID : 5M

Family: Beam - Column web (BCW)
Type: Directly welded flanges

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 10X39
Beam material	:	A992 Gr50
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
sb: Beam setback	:	0.5 in

Column

General

Support section	:	HSS_SQR 8X8X1_4
Support material	:	A500 GrB rectangular

Design code: AISC 360-16 LRFD

DEMANDS

Description	Ru [kip]	Pu [kip]	Mu [kip*ft]	PufTop [kip]	PufBot [kip]	Load type
DL	0.00	0.00	16.78	-21.44	21.44	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Support						
Flange wall slenderness		34.33	--	--	✓	
Web wall slenderness		34.33	--	--	✓	
Beam flange / support width ratio		1.00	--	--	✓	
Yield stress	[Kip/in2]	46.00	--	--	✓	
Yield stress to tensile stress ratio		0.79	--	0.80	✓	Table K2.1A, Table K2.1

DESIGN CHECK

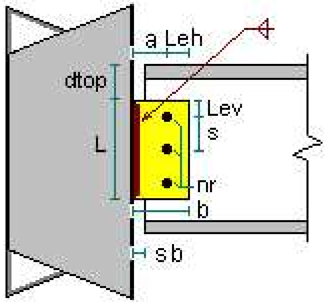
Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Support						
Local yielding due to uneven load distribution	[Kip]	22.45	21.44	DL	**0.96**	Eq. J4-1
Side wall local yielding	[Kip]	48.82	21.44	DL	**0.44**	Eq. J4-3
Side wall local buckling	[Kip]	86.45	21.44	DL	**0.25**	Eq. J10-8
Global critical strength ratio	**0.96**					

Connection name : SP BCW
Connection ID : 6V

Family: Beam - Column web (BCW)
Type: Single plate

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 27X114
Beam material	:	A992 Gr50
sb: Beam setback	:	0.5 in
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
Horizontal eccentricity	:	0 in

Coped

dct: Top cope depth	:	0 in
ct: Top cope length	:	0 in
dcb: Bottom cope depth	:	0 in
cb: Bottom cope length	:	0 in

Column

General

Support section	:	HSS_SQR 8X8X1_4
Support material	:	A500 GrB rectangular

SINGLE PLATE

Connector

Section	:	PL 1/4x4x21
b: Width	:	4 in
L: Length	:	21 in
tp: Plate thickness	:	0.25 in
Material	:	A36
Plate position on beam	:	Center
Bolts	:	3/4" A325 N
nr: Rows of Bolts	:	7
nc: Bolt columns	:	1
s: Pitch - longitudinal center-to-center spacing	:	3 in
Lev: Vertical edge distance	:	1.5 in
Leh: Horizontal edge distance	:	1.5 in
a: Distance between weld and bolts	:	2.5 in
Hole type on plate	:	Standard (STD)
Hole type on beam	:	Standard (STD)
Welding electrode to support	:	E70XX
D: Weld size to support (1/16 in)	:	3
Wo: Obtuse side weld size (AWS) (1/16 in)	:	3
Wa: Acute side weld size (AWS) (1/16 in)	:	3
Wo: Obtuse side weld size (AISC) (1/16 in)	:	3
Wa: Acute side weld size (AISC) (1/16 in)	:	3

Design code: AISC 360-16 LRFD

DEMANDS

Description	Beam Ru [kip]	Beam Pu [kip]	Column Pu [kip]	Column Mu22 [kip*ft]	Column Mu33 [kip*ft]	Load type
DL	27.24	0.00	-28.99	30.60	0.00	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Shear plate						
Thickness	[in]	0.25	--	0.34	✓	p. 10-103
Length	[in]	21.00	12.12	24.24	✓	p. 10-104
Thickness, precludes a punching failure of the HSS...	[in]	0.25	--	--	✓	
Vertical edge distance	[in]	1.50	1.00	--	✓	Tables J3.4, J3.5
Horizontal edge distance	[in]	1.50	1.50	--	✓	p. 10-103
Vertical center-to-center spacing (pitch)	[in]	3.00	2.00	6.00	✓	Sec. J3.3, Sec. J3.5
Beam						
Vertical edge distance	[in]	4.65	1.00	--	✓	Tables J3.4, J3.5
Horizontal edge distance	[in]	2.00	1.50	--	✓	p. 10-103
Support						
Maximum value of the specified yield stress	[Kip/in2]	46.00	--	--	✓	
Yield stress to tensile stress ratio		0.79	--	0.80	✓	Table K2.1A, Table K2.1
Weld size	[1/16in]	3	3	--	✓	p. 10-87
Weld length	[in]	21.00	0.75	--	✓	Sec. J2.2b

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Shear plate						
Bolts shear	[Kip]	112.47	27.24	DL	**0.24**	Tables (7-1..14)
Bolt bearing under shear load	[Kip]	118.23	27.24	DL	**0.23**	p. 7-18, Sec. J3.10
Shear yielding	[Kip]	113.40	27.24	DL	**0.24**	Eq. J4-3
Shear rupture	[Kip]	97.06	27.24	DL	**0.28**	Eq. J4-4
Block shear	[Kip]	90.53	27.24	DL	**0.30**	Eq. J4-5
Flexural rupture	[Kip]	342.56	27.24	DL	**0.08**	p. 9-10
Plate (support side)						
Weld capacity	[Kip]	175.41	27.24	DL	**0.16**	Tables 8-4 .. 8-11
Shear yielding/buckling and flexure yielding		1.00	0.06	DL	**0.06**	Eq. 10-5
Beam						
Bolt bearing under shear load	[Kip]	314.27	27.24	DL	**0.09**	p. 7-18, Sec. J3.10
Shear yielding	[Kip]	466.83	27.24	DL	**0.06**	Eq. J4-3
Support						
Welds rupture	[Kip/ft]	97.30	10.38	DL	**0.11**	p. 9-5
Chord wall plastification	[Kip]	22.08	0.00	DL	**0.00**	Eq. J4-5
Punching shear (shear rupture)	[Kip]	357.58	27.24	DL	**0.08**	p. 10-153
Global critical strength ratio	**0.30**					

NOTES

The plate is designed with the extended configuration criteria.

REFERENCES

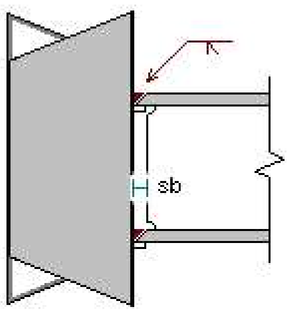
[4] AISC 2005, Design Examples Version 13.0, pp. IIA-63, IIA_86, IIA-98

Connection name : DW BCW
Connection ID : 7M

Family: Beam - Column web (BCW)
Type: Directly welded flanges

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 16X36
Beam material	:	A992 Gr50
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
sb: Beam setback	:	0.5 in

Column

General

Support section	:	HSS_SQR 8X8X1_2
Support material	:	A500 GrB rectangular

Design code: AISC 360-16 LRFD

DEMANDS

Description	Ru [kip]	Pu [kip]	Mu [kip*ft]	PufTop [kip]	PufBot [kip]	Load type
DL	0.00	0.00	48.19	-37.38	37.38	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Support						
Flange wall slenderness		17.20	--	--	✓	
Web wall slenderness		17.20	--	--	✓	
Beam flange / support width ratio		0.87	--	--	✓	
Yield stress	[Kip/in2]	46.00	--	--	✓	
Yield stress to tensile stress ratio		0.79	--	0.80	✓	Table K2.1A, Table K2.1

DESIGN CHECK

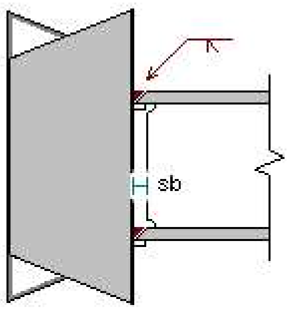
Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Support						
Local yielding due to uneven load distribution	[Kip]	78.22	37.38	DL	**0.48**	Eq. J4-1
Shear yielding (punching)	[Kip]	115.32	37.38	DL	**0.32**	Eq. J4-3
Side wall local yielding	[Kip]	167.59	37.38	DL	**0.22**	Eq. J4-3
Side wall local buckling	[Kip]	759.53	37.38	DL	**0.05**	Eq. J10-8
Global critical strength ratio	**0.48**					

Connection name : DW BCW
Connection ID : 8M

Family: Beam - Column web (BCW)
Type: Directly welded flanges

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 10X39
Beam material	:	A992 Gr50
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
sb: Beam setback	:	0.5 in

Column

General

Support section	:	HSS_SQR 8X8X1_2
Support material	:	A500 GrB rectangular

Design code: AISC 360-16 LRFD

DEMANDS

Description	Ru [kip]	Pu [kip]	Mu [kip*ft]	PufTop [kip]	PufBot [kip]	Load type
DL	0.00	0.00	30.17	-38.56	38.56	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Support						
Flange wall slenderness		17.20	--	--	✔	
Web wall slenderness		17.20	--	--	✔	
Beam flange / support width ratio		1.00	--	--	✔	
Yield stress	[Kip/in2]	46.00	--	--	✔	
Yield stress to tensile stress ratio		0.79	--	0.80	✔	Table K2.1A, Table K2.1

DESIGN CHECK

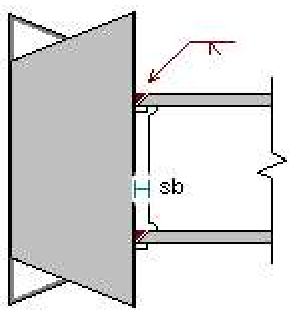
Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Support						
Local yielding due to uneven load distribution	[Kip]	89.41	38.56	DL	0.43	Eq. J4-1
Side wall local yielding	[Kip]	171.87	38.56	DL	0.22	Eq. J4-3
Side wall local buckling	[Kip]	759.53	38.56	DL	0.05	Eq. J10-8
Global critical strength ratio	**0.43**					

Connection name : DW BCW
Connection ID : 9M

Family: Beam - Column web (BCW)
Type: Directly welded flanges

GENERAL INFORMATION

Connector



MEMBERS

Beam

General

Beam section	:	W 10X39
Beam material	:	A992 Gr50
Horizontal angle (deg)	:	0
Vertical angle (deg)	:	0
sb: Beam setback	:	0.5 in

Column

General

Support section	:	HSS_SQR 8X8X1_2
Support material	:	A500 GrB rectangular

Design code: AISC 360-16 LRFD

DEMANDS

Description	Ru [kip]	Pu [kip]	Mu [kip*ft]	PufTop [kip]	PufBot [kip]	Load type
DL	0.00	0.00	30.17	-38.56	38.56	Design

GEOMETRIC CONSIDERATIONS

Dimensions	Unit	Value	Min. value	Max. value	Sta.	References
Support						
Flange wall slenderness		17.20	--	--	✔	
Web wall slenderness		17.20	--	--	✔	
Beam flange / support width ratio		1.00	--	--	✔	
Yield stress	[Kip/in2]	46.00	--	--	✔	
Yield stress to tensile stress ratio		0.79	--	0.80	✔	Table K2.1A, Table K2.1

DESIGN CHECK

Verification	Unit	Capacity	Demand	Ctrl EQ	Ratio	References
Support						
Local yielding due to uneven load distribution	[Kip]	89.41	38.56	DL	**0.43**	Eq. J4-1
Side wall local yielding	[Kip]	171.87	38.56	DL	**0.22**	Eq. J4-3
Side wall local buckling	[Kip]	759.53	38.56	DL	**0.05**	Eq. J10-8
Global critical strength ratio	**0.43**					

Components and Cladding

Note: Component and Cladding Zones 1-5 in reference to Figure 30.3 in ASCE/SEI 7-16

$p = p_{table}(EAF)(RF)K_{zt}$

EAF = 0.692

10 sqft:

Minus:

1: RF = NA
2: RF = NA
3: RF = NA
4: RF = 1
5: RF = 1

Plus:

1: RF = 1
2: RF = 1
3: RF = 1
4: RF = 1
5: RF = 1

50 sqft:

Minus:

1: RF = NA
2: RF = NA
3: RF = NA
4: RF = 0.88
5: RF = 0.88

Plus:

1: RF = 0.88
2: RF = 0.88
3: RF = 0.88
4: RF = 0.92
5: RF = 0.84

100 sqft:

Minus:

1: RF = NA
2: RF = NA
3: RF = NA
4: RF = 0.82
5: RF = 0.82

Plus:

1: RF = 0.82
2: RF = 0.82
3: RF = 0.82
4: RF = 0.88
5: RF = 0.76

K_{zt} = 1.64

Pressures (psf):

10 sqft:

Minus:

1: RF = -65.9
2: RF = -103.5
3: RF = -141.1
4: RF = -53.5
5: RF = -82.6

Plus:

1: RF = 20.1
2: RF = 20.1
3: RF = 20.1
4: RF = 49.3
5: RF = 49.3

50 sqft:

Minus:

1: RF = -65.9
2: RF = -103.5
3: RF = -141.1
4: RF = -47.1
5: RF = -72.7
Plus:

1: RF = 17.7
2: RF = 17.7
3: RF = 17.7
4: RF = 45.4
5: RF = 41.4

100 sqft:

Minus:

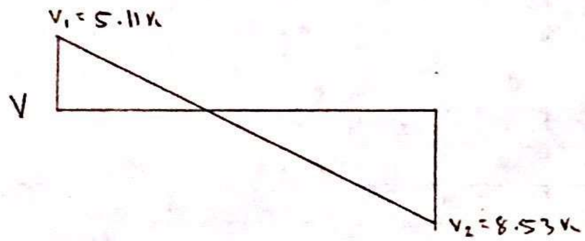
1: RF = -65.9
2: RF = -103.5
3: RF = -141.1
4: RF = -43.9
5: RF = -67.7

Plus:

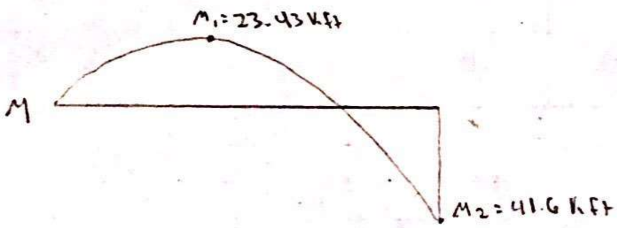
1: RF = 16.5
2: RF = 16.5
3: RF = 16.5
4: RF = 43.4
5: RF = 37.5

W14x43 (A992)
- Pin fixed supports
- $L = 24.438'$
- $w_D = w_{RLL} = 0.298\ ^k/_{ft}$
- $1.2D + 0.5RLL$ check (LC5)

Loading:
$1.2(0.298\ ^k/_{ft} + 0.043\ ^k/_{ft}) + 0.5(0.298\ ^k/_{ft}) : 0.5582\ ^k/_{ft}$



$$V_1 = \frac{3wl}{8} = \frac{3(0.5582\ ^k/_{ft})(24.438')}{8} = 5.11\ k$$
$$V_2 = \frac{5wl}{8} = \frac{5(0.558\ ^k/_{ft})(24.438')}{8} = 8.53\ k$$



$$M_1 = \frac{9}{128} wl^2 = \frac{9}{128}(0.558\ ^k/_{ft})(24.438')^2 = 23.43\ k\,ft$$
$$M_2 = \frac{wl^2}{8} = \frac{(0.558\ ^k/_{ft})(24.438')^2}{8} = 41.6\ k\,ft$$

Available shear from M21 → $\boxed{V_n/\Omega = 83.6k}$

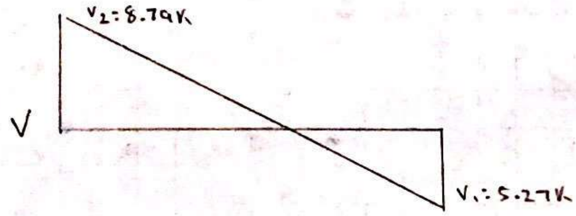
Available Flexure

$M_n = M_p = (50\ ksi)(69.6\ in^3) = 3480\ k\,in$

$$C_b = \frac{12.5(42.452)}{2.5(42.452) + 3(20.312) + 4(20.644) + 3(0.278)} = 2.12$$
$L_p = 80.16"$
$L_r = 240"$
$L_b = 293.26"$
$$F_{cr} = \frac{2.12(\pi^2)(29000)}{(293.26/2.18)^2}\sqrt{1 + 0.078\frac{1.05}{62.6(13.2)}\left(\frac{293.26}{2.18}\right)^2} = 52.86\ ksi$$
$M_n = 52.86\ ksi(62.6\ in^3) = 3309\ k\,in$
$$\frac{M_n}{\Omega} = \frac{3309\ k\,in}{1.67} = \boxed{1981.5\ Kin}$$

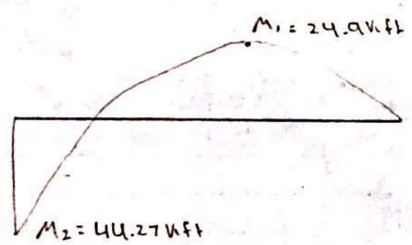
W14x43 (A992)
- Pin fixed supports
- $L = 25.192'$
- $w_D = w_{RLL} = 0.298^{k}/ft$
- $1.2D + 0.5RLL$ check (LC5)

Loading:
$1.2(0.298^{k}/ft + 0.043^{k}/ft) + 0.5(0.298^{k}/ft) = 0.5582^{k}/ft$



$$V_2 = \frac{5wl}{8} = \frac{5(0.558^{k}/ft)(25.192')}{8} = 8.79K$$

$$V_1 = \frac{3wl}{8} = \frac{3(0.558^{k}/ft)(25.192')}{8} = 5.27K$$



$$M_2 = \frac{wl^2}{8} = \frac{(0.558^{k}/ft)(25.192')^2}{8} = 44.27 Kft$$

$$M_1 = \frac{9}{128} wl^2 = \frac{9}{128}(0.558^{k}/ft)(25.192')^2 = 24.90 Kft$$

Available Shear

$V_n = 0.6F_y A_w C_{v1}$

$\frac{h}{t_w} = 37.4 \qquad 2.24\sqrt{\frac{29000}{50}} = 53.95 \quad \rightarrow \quad \Omega = 1.5$

$A_w = (13.7")(0.305") = 4.18\ in^2$

$V_n = 0.6(50ksi)(4.18in^2)(1.0) = 125.4K$

$\frac{V_n}{\Omega} = \frac{125.4K}{1.5} = \boxed{83.6K}$

Available Flexure

$M_n = M_p = (50\text{ksi})(69.6\text{ in}^3) = 3480 \text{ Kin}$

$$C_b = \frac{12.5(42.67)}{2.5(42.67)+3(0.19)+4(22.711)+3(22.648)} = 2.0$$

$L_p = 80.16"$

$L_r = 240"$

$L_b = 302.3"$

$$F_{cr} = \frac{(2.0)\pi^2(29000)}{(302.3/2.18)^2}\sqrt{1+0.078\frac{1.05}{62.6(13.2)}\left(\frac{302.3}{2.18}\right)^2} = 50.75 \text{ Ksi}$$

$M_n = 50.75 \text{ Ksi}(62.6\text{ in}^3) = 3176.72 \text{ Kin}$

$\Omega = 1.67$

$$\frac{M_n}{\Omega} = \frac{3176.72}{1.67} = \boxed{1902.2 \text{ Kin}}$$

HSS 8x8x3/16
- Pinned support
- L = 12'
- 1.2D + 0.5RLL check (LCS)

Moment = $(M_2)_{M21} - (M_1)_{M15} = 44.27\text{kft} - 41.6\text{kft} = 2.67\text{kft}$

Axial top = $(V_1)_{M21} + (V_2)_{M15} = 8.53k + 8.74k = 17.3k$

Axial bot = 17.3k + self weight = $17.3k + 0.01963^{k}/_{ft}(12') = 17.54k$

Available Axial

$\frac{b}{t} = 43 \qquad 1.4\sqrt{\frac{29000}{46}} = 35.15 \rightarrow$ Slender

$F_e = \frac{\pi^2(29000)}{(144/3.18)^2} \; 139.58\text{ksi}$

$\frac{F_y}{F_e} = \frac{46}{139.58} = 0.3296$

$F_{cr} = \left(0.658^{0.3296}\right)(46\text{ksi}) = 40.07\text{ksi}$

$35.15\sqrt{\frac{46}{40.07}} = 37.66 > 43 \rightarrow$ E7-3

$C_1 = 0.2 \quad C_2 = 1.38$

$F_{el} = \left(1.38\,\frac{35.15}{43}\right)^2(46\text{ksi}) = 58.54\text{ksi}$

$b_e = 8.0\left(1 - 0.2\sqrt{\frac{58.54}{40.07}}\right)\sqrt{\frac{58.54}{40.07}} = 7.33$

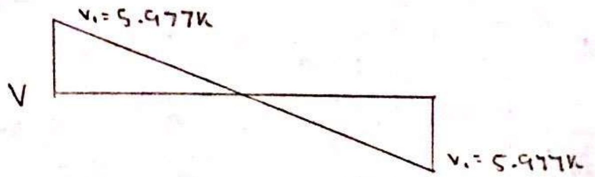
$A_e = 5.37\text{in}^2 - 4(8'' - 7.332'')(0.174'') = 4.91\text{in}^2$

$P_n = (40.07\text{ksi})(4.91\text{in}^2) = 196.74k$

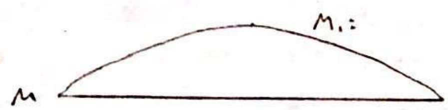
$\frac{P_n}{\Omega} = \frac{196.74k}{1.67} = \boxed{117.81k}$

W18x65 (A992)
- Pin Pin supports
- L = 28.833'
- $W_D = W_{RLL} = 0.198\ k/ft$
- 1.2D + 0.5RLL check (LC5)

Loading:
$1.2(0.198^{k}/ft + 0.065^{k}/ft) + 0.5(0.198^{k}/ft) = 0.4146^{k}/ft$



$$V_1 = \frac{wl}{2} = \frac{(0.4146^{k}/ft)(28.833')}{2} = 5.977k$$



$$M_1 = \frac{wl^2}{8} = \frac{(0.4146^{k}/ft)(28.833')^2}{8} = 43.1\ k\,ft$$

Available Shear

$A_w = (18.4")(0.495") = 9.108\ in^2$
$V_n = 0.6(50ksi)(9.108\ in^2)(1.0) = 273.24\ k$
$\frac{h}{t_w} = 35.7 \qquad 2.24\sqrt{\frac{29000}{50}} = 53.95 \qquad \therefore \Omega = 1.5$
$\frac{V_n}{\Omega} = \frac{257.24k}{1.5} = \boxed{182.2\ k}$

Available Flexure

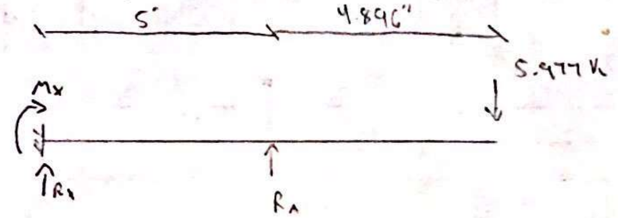
$M_n = M_p = 50ksi(133\ in^3) = 6650\ k\,in$

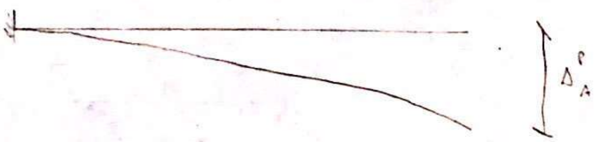
$L_p = 71.64"$
$L_r = 225.6$
$L_b = 345.99"$

$$C_b = \frac{12.5(43.08)}{2.5(43.08) + 3(31.65) + 4(43.08) + 3(32.53)} = 1.14$$

$$F_{cr} = \frac{1.14(\pi^2)(29000)}{(346/2.03)^2}\sqrt{1 + 0.078\frac{2.73}{117(17.7)}\left(\frac{346}{2.03}\right)^2} = 22.43\ ksi$$

$M_n = (22.43ksi)(117\ in^3) = 2624.31$
$\frac{M_n}{\Omega} = \frac{2624.31}{1.67} = \boxed{1571.4\ k\,in}$





loading $= 1.2(0.065^{k}/ft) = 0.078^{k}/ft = 0.0065^{k}/in$

$$\Delta = \frac{w}{24EI}\left(x^4 - 4l^3x + 3l^4\right) + \frac{P}{6EI}\left(2l^3 - 3l^2x + x^3\right)$$

$$= \frac{0.0065^{k}/in}{24(29000\,ksi)(1070\,in^4)}\left((58.752in)^4 - 4(58.752in)(118.752)^3 + 3(118.752in)^4\right) +$$

$$\frac{5.977k}{6(29000\,ksi)(1070\,in^4)}\left(2(118.752in)^3 - 3(118.752in)^2(58.752in) + (58.752in)^3\right)$$

$$= 0.03612\,in$$

$$\Delta_x = \frac{1k}{6(29000\,ksi)(1070\,in^4)}\left(2(118.752in)^3 - 3(118.752in)^2(58.752in) + (58.752in)^3\right)$$

$$= 0.005728\,in$$

$\Delta - \Delta_R R_A = 0$

$0.03612in - 0.005728^{in}/_{k}(R_A) = 0$

$R_A = 6.306k$

$\Sigma M_x: -M_x + 6.306k(5') - 5.977k(4.896') + 0.078^{k}/ft(4.896')^2(0.5) = 0$

$M_x = 23.8\,k\text{-}ft$

$\Sigma F_y: 6.306k - 5.977k + R_x = 0$

$R_x = -0.329\,k$

HSS 12x8x 5/16
- fixed support
- L = 16'
- 1.2D + 0.5RLL check (LC5)

Load from MS5 = 12.16k
Load from MS3 = 0.144k

Axial top = $(V_1)_{MS5} + (V_2)_{MS3}$ = 12.16k + 0.144k = 12.304k
Axial bot = Axial top + selfweight = 12.304k + 0.0479 k/ft (16') = 13.1k

Available Axial

$\frac{b}{t} = 19.9$ $\quad 1.4\sqrt{\frac{29000}{46}} = 35.15$ $\quad \therefore$ nonslender

$\frac{h}{t} = 31.4$ $\quad \therefore$ nonslender

$Fe = \frac{\pi^2 (29000)}{(192/3.21)^2} = 80 ksi$

$\frac{F_y}{Fe} = \frac{46}{80} = 0.575$

$Fcr = (0.658^{0.575})(46 ksi) = 36.16 ksi$

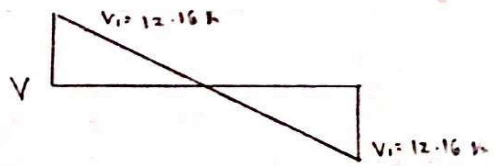
$P_n = (36.16 ksi)(13.2 in^2) = 477.3 k$

$\frac{P_n}{\Omega} = \frac{477.3k}{1.67} = \boxed{285.82k}$

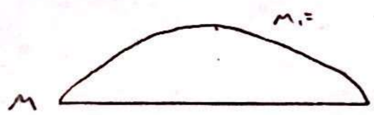
W18×76 (A992)
- Pin Pin Supports
- $L = 33'$
- $W_D = W_{RLL} = 0.38\ k/ft$
- $1.2D + 0.5RLL$ check (LC5)

Loading:

$1.2(0.38\ k/ft + 0.076\ k/ft) + 0.5(0.38\ k/ft) = 0.7372\ k/ft$



$$V_1 = \frac{wl}{2} = \frac{(0.7372\ k/ft)(33')}{2} = 12.16$$



$$M_1 = \frac{wl^2}{8} = \frac{(0.7372\ k/ft)(33')^2}{8} = 100.35\ kft$$

Available Shear

$A_v = (18.2")(0.425") = 7.735\ in^2$

$V_n = 0.6(50\ ksi)(7.735\ in^2)(1.0) = 232.1\ k$

$\frac{h}{t_w} = 37.8 \qquad 2.24\sqrt{\frac{29000}{50}} = 53.95 \qquad \Omega = 1.5$

$\frac{V_n}{\Omega} = \frac{232.1\ k}{1.5} = \boxed{154.7\ k}$

Available Flexure

$M_n = M_p = (50\ ksi)(163\ in^3) = 8150\ k\cdot in$

$L_p = 110.64"$

$L_r = 325.2"$

$L_b = 396"$

$C_b = 1.14$

$$F_{cr} = \frac{1.14(\pi^2)(29000)}{(396/3.02)^2}\sqrt{1 + 0.078\frac{2.83}{146(17.5)}\left(\frac{396}{3.02}\right)^2} = 29.9\ ksi$$

$M_n = (29.9\ ksi)(146\ in^3) = 4365.4\ k\,in$

$\frac{M_n}{\Omega} = \frac{4365.4\ k\,in}{1.67} = \boxed{2614\ k\,in}$

HSS 7x7x1/4 col   A500 Gr B
W14x34 bm   A992 Gr 50
V = 8.39 k

(3) 3/4" A325 N
PL 1/4 x 4 x 9

Shear plate

Bolt shear

$\phi R_n = (54 ksi)\frac{\pi}{4}(3/4)^2(0.75) = 17.89 k$ $3(17.89k) = 53.68 k > 8.39k$

Bolt Bearing

$\phi R_n = 2.4(3/4")(1/4")(58 ksi)(0.75) = 19.58k > 8.39k$

Shear yielding

$\phi R_n = 0.6(36ksi)(0.25")(9")(1.0) = 48.6k > 8.39k$

Shear rupture

$\phi R_n = 0.6(58ksi)(0.25"(9") - 3(13/16")(0.25"))(0.75) = 42.8k > 8.39k$

Block Shear

$R_n = 0.6(58ksi)(0.25"(9") - 3(13/16")(0.25")) \leq 0.6(36ksi)(0.25")(10.5) = 56.7 k$

$\phi R_n = 42.5 k > 8.39k$

Plate support side

Weld capacity

$C = 3.71 \rightarrow$ Table 8-4 $C_1 = 1.0 \rightarrow E70xx$

$\phi R_n = 0.75(3.71 k/in)(1)(3)(9") = 75.13 k > 8.39k$

Beam

Bearing

$2.4(3/4")(0.27")(65 ksi)(0.75) = 23.69k > 8.39k$

Tearout

$1.2(0.6875")(0.27")(65 ksi)(0.75) = 10.86 k > 8.39k$

Appendix D: Foundation Design Calculations

Note: The project site is in seismic Class D. This means that IBC 2018 requires consideration of seismic limit states of the structural fill material including determination of slope instability, liquefaction, total and differential settlement, and surface displacement due to faulting or seismically induced lateral spreading for compliance based on the site's seismic design category. These values were not used for foundation calculations based on the assumption of fill classification but are required to be confirmed before construction. Additional seismic considerations should be considered as appropriate based on IBC 2018 Section 1803.5.

1803.5.10 Alternate setback and clearance.

Where setbacks or clearances other than those required in Section 1808.7 are desired, the *building official* shall be permitted to require a geotechnical investigation by a *registered design professional* to demonstrate that the intent of Section 1808.7 would be satisfied. Such an investigation shall include consideration of material, height of slope, slope gradient, load intensity and erosion characteristics of slope material.

1803.5.11 Seismic Design Categories C through F.

For structures assigned to *Seismic Design Category* C, D, E or F, a geotechnical investigation shall be conducted, and shall include an evaluation of all of the following potential geologic and seismic hazards:

1. Slope instability.
2. Liquefaction.
3. Total and differential settlement.
4. Surface displacement due to faulting or seismically induced lateral spreading or lateral flow.

1803.5.12 Seismic Design Categories D through F.

For structures assigned to *Seismic Design Category* D, E or F, the geotechnical investigation required by Section 1803.5.11 shall include all of the following as applicable:

1. The determination of dynamic seismic lateral earth pressures on foundation walls and retaining walls supporting more than 6 feet (1.83 m) of backfill height due to design earthquake ground motions.
2. The potential for liquefaction and soil strength loss evaluated for site peak ground acceleration, earthquake magnitude and source characteristics consistent with the maximum considered earthquake ground motions. Peak ground acceleration shall be determined based on one of the following:
   - 2.1. A site-specific study in accordance with Chapter 21 of ASCE 7.
   - 2.2. In accordance with Section 11.8.3 of ASCE 7.
3. An assessment of potential consequences of liquefaction and soil strength loss including, but not limited to, the following:
   - 3.1. Estimation of total and differential settlement.
   - 3.2. Lateral soil movement.
   - 3.3. Lateral soil loads on foundations.
   - 3.4. Reduction in foundation soil-bearing capacity and lateral soil reaction.
   - 3.5. Soil downdrag and reduction in axial and lateral soil reaction for pile foundations.
   - 3.6. Increases in soil lateral pressures on retaining walls.
   - 3.7. Flotation of buried structures.
4. Discussion of mitigation measures such as, but not limited to, the following:
   - 4.1. Selection of appropriate foundation type and depths.
   - 4.2. Selection of appropriate structural systems to accommodate anticipated displacements and forces.
   - 4.3. Ground stabilization.
   - 4.4. Any combination of these measures and how they shall be considered in the design of the structure.

Soil Classification:

Based on Chapter 18 of IBC 2018

ASTM D2487 Classification: Well-Graded and/or Poorly Graded Gravel (GW or GP)

Compaction:	95% standard proctor max dry density
Allowable Vertical Bearing:	3 ksf
Lateral Bearing Pressure:	0.2 ksf/ft below grade

Coefficient of Friction:	0.35
Cohesion:	Negligible
Subgrade Modulus:	100k/ft3

1803.5 Investigated conditions.

Geotechnical investigations shall be conducted as indicated in Sections 1803.5.1 through 1803.5.12.

1803.5.1 Classification.

Soil materials shall be classified in accordance with ASTM D2487.

1803.5.2 Questionable soil.

Where the classification, strength or compressibility of the soil is in doubt or where a load-bearing value superior to that specified in this code is claimed, the *building official* shall be permitted to require that a geotechnical investigation be conducted.

1803.5.3 Expansive soil.

In areas likely to have expansive soil, the *building official* shall require soil tests to determine where such soils do exist.

Soils meeting all four of the following provisions shall be considered to be expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

1. Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D4318.
2. More than 10 percent of the soil particles pass a No.200 sieve (75 μm), determined in accordance with ASTM D422.
3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422..
4. Expansion index greater than 20, determined in accordance with ASTM D4829.

1803.5.4 Ground-water table.

A subsurface soil investigation shall be performed to determine whether the existing ground-water table is above or within 5 feet (1524 mm) below the elevation of the lowest floor level where such floor is located below the finished ground level adjacent to the foundation.

Exception: A subsurface soil investigation to determine the location of the ground-water table shall not be required where waterproofing is provided in accordance with Section 1805.

SECTION 1806
PRESUMPTIVE LOAD-BEARING VALUES OF SOILS

1806.1 Load combinations.

The presumptive load-bearing values provided in Table 1806.2 shall be used with the *allowable stress design* load combinations specified in Section 1605.3 . The values of vertical foundation pressure and lateral bearing pressure given in Table 1806.2 shall be permitted to be increased by one-third where used with the alternative basic load combinations of Section 1605.3.2 that include wind or earthquake loads.

1806.2 Presumptive load-bearing values.

The load-bearing values used in design for supporting soils near the surface shall not exceed the values specified in Table 1806.2 unless data to substantiate the use of higher values are submitted and *approved*. Where the *building official* has reason to doubt the classification, strength or compressibility of the soil, the requirements of Section 1803.5.2 shall be satisfied.

Presumptive load-bearing values shall apply to materials with similar physical characteristics and dispositions. Mud, organic silt, organic clays, peat or unprepared fill shall not be assumed to have a presumptive load-bearing capacity unless data to substantiate the use of such a value are submitted.

Exception: A presumptive load-bearing capacity shall be permitted to be used where the *building official* deems the load-bearing capacity of mud, organic silt or unprepared fill is adequate for the support of lightweight or temporary structures.

TABLE 1806.2 PRESUMPTIVE LOAD-BEARING VALUES

CLASS OF MATERIALS	VERTICAL FOUNDATION PRESSURE (psf)	LATERAL BEARING PRESSURE (psf/ft below natural grade)	LATERAL SLIDING RESISTANCE	
			Coefficient of friction[a]	Cohesion (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and gravel (GW and GP)	3,000	200	0.35	—
4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	—
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500	100	—	130

For SI: 1 pound per square foot = 0.0479kPa, 1 pound per square foot per foot = 0.157 kPa/m.

a. Coefficient to be multiplied by the dead load.
b. Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2 .

1806.3 Lateral load resistance.

Where the presumptive values of Table 1806.2 are used to determine resistance to lateral loads, the calculations shall be in accordance with Sections 1806.3.1 through 1806.3.4.

Frost Depth:

SECTION 1809
SHALLOW FOUNDATIONS ES

1809.1 General.
Shallow foundations shall be designed and constructed in accordance with Sections 1809.2 through 1809.13.

1809.2 Supporting soils.
Shallow foundations shall be built on undisturbed soil, compacted fill material or controlled low-strength material (CLSM). Compacted fill material shall be placed in accordance with Section 1804.5 . CLSM shall be placed in accordance with Section 1804.6 .

1809.3 Stepped footings.
The top surface of footings shall be level. The bottom surface of footings shall be permitted to have a slope not exceeding one unit vertical in 10 units horizontal (10-percent slope). Footings shall be stepped where it is necessary to change the elevation of the top surface of the footing or where the surface of the ground slopes more than one unit vertical in 10 units horizontal (10-percent slope).

1809.4 Depth and width of footings.
The minimum depth of footings below the undisturbed ground surface shall be 12 inches (305 mm). Where applicable, the requirements of Section 1809.5 shall be satisfied. The minimum width of footings shall be 12 inches (305 mm).

1809.5 Frost protection.
Except where otherwise protected from frost, foundations and other permanent supports of buildings and structures shall be protected from frost by one or more of the following methods:

1. Extending below the frost line of the locality.
2. Constructing in accordance with ASCE 32.
3. Erecting on solid rock.

Exception: Free-standing buildings meeting all of the following conditions shall not be required to be protected:

1. Assigned to *Risk Category* I.
2. Area of 600 square feet (56 m^2) or less for light-frame construction or 400 square feet (37 m^2) or less for other than light-frame construction.
3. Eave height of 10 feet (3048 mm) or less.

Shallow foundations shall not bear on frozen soil unless such frozen condition is of a permanent character.

1809.6 Location of footings.
Footings on granular soil shall be so located that the line drawn between the lower edges of adjoining footings shall not have a slope steeper than 30 degrees (0.52 rad) with the horizontal, unless the material supporting the higher footing is braced or retained or otherwise laterally supported in an *approved* manner or a greater slope has been properly established by engineering analysis.

Anchor Rods:

Material:	ASTM F1554 Grade 36
Diameter:	¾”
Hole Diameter:	1.3125”
Length:	9”

Anchor Rod Modifications should be done in accordance with Ch 2 of AISC Steel Design Guide: Base Plate and Anchor Rod Design umn shaft. The column may or may not be welded after erection depending on the structural requirements and the type of erection aid provided. Most erectors now prefer to have the base plate shop welded to the column whenever possible.

2.5 Anchor Rod Material

As shown in Table 2.2, the preferred specification for anchor rods is ASTM F1554, with Grade 36 being the most common strength level used. The availability of other grades should be confirmed prior to specification.

ASTM F1554 Grade 55 anchor rods are used when there are large tension forces due to moment connections or uplift from overturning. ASTM F1554 Grade 105 is a special high-strength rod grade and generally should be used only when it is not possible to develop the required strength using larger Grade 36 or Grade 55 rods.

Unless otherwise specified, anchor rods will be supplied with unified coarse (UNC) threads with a Class 2a tolerance, as permitted in ASTN F1554. While ASTM F1554 permits standard hex nuts, all nuts for anchor rods, especially those used in base plates with large oversize holes, should be furnished as heavy hex nuts, preferably ASTM A563 Grade A or DH for Grade 105.

ASTM F1554 anchor rods are required to be color coded to allow easy identification in the field. The color codes are as follows:

Grade 36 .... Blue
Grade 55 .... Yellow
Grade 105 .... Red

In practice, Grade 36 is considered the default grade and often is not color coded.

Figure 2.2. Base plate with adjusting screws.

The ASTM specification allows F1554 anchor rods to be supplied either straight (threaded with nut for anchorage), bent or headed. Rods up to approximately 1 in. in diameter are sometimes supplied with heads hot forged similar to a structural bolt. Thereafter, it is more common that the rods will be threaded and nutted.

Hooked-type anchor rods have been extensively used in the past. However, hooked rods have a very limited pullout strength compared with that of headed rods or threaded rods with a nut for anchorage. Therefore, current recommended practice is to use headed rods or threaded rods with a nut for anchorage.

The addition of plate washers or other similar devices does not increase the pullout strength of the anchor rod and can create construction problems by interfering with reinforcing steel placement or concrete consolidation under the plate. Thus, it is recommended that the anchorage device be limited to either a heavy hex nut or a head on the rod. As an exception, the addition of plate washers may be of use when high-strength anchor rods are used or when concrete blowout could occur (see Section 3.22 of this Guide). In these cases, calculations should be made to determine if an increase in the bearing area is necessary. Additionally, it should be confirmed that the plate size specified will work with the reinforcing steel and concrete placement requirements.

ASTM F1554 Grade 55 anchor rods can be ordered with a supplementary requirement, S1, which limits the carbon equivalent content to a maximum of 45%, to provide weldability when needed. Adding this supplement is helpful should welding become required for fixes in the field. Grade 36 is typically weldable without supplement.

There are also two supplemental provisions available for Grades 55 and 105 regarding Charpy V-Notch (CVN) toughness. These provide for CVN testing of 15 ft-lbs at either 40 °F (S4) or at –20 °F (S5). Note, however, that anchor rods typically have sufficient fracture toughness without these supplemental specifications. Additional fracture toughness is expensive and generally does not make much difference in the time to failure for anchor rods subjected to fatigue loading. Although fracture toughness may correspond to a greater crack length at the time of failure (because cracks grow at an exponential rate) 95% of the fatigue life of the anchor rod is consumed when the crack size is less than a few millimeters. This is also the reason it is not cost effective to perform ultrasonic testing or other nondestructive tests on anchor rods to look for fatigue cracks. There is only a small window between the time cracks are large enough to detect and small enough to not cause fracture. Thus, it generally is more cost effective to design additional redundancy into the anchor rods rather than specifying supplemental CVN properties.

Table 2.3. Recommended Sizes for Anchor Rod Holes in Base Plates			
Anchor Rod Diameter, in.	**Hole Diameter, in.**	**Min. Washer Dimension, in.**	**Min. Washer Thickness, in.**
¾	1$\frac{5}{16}$	2	¼
⅞	1$\frac{9}{16}$	2½	$\frac{5}{16}$
1	1$\frac{13}{16}$	3	⅜
1¼	2$\frac{1}{16}$	3	½
1½	2$\frac{5}{16}$	3½	½
1¾	2¾	4	⅝
2	3¼	5	¾
2½	3¼	5½	⅞

Notes: 1. Circular or square washers meeting the size shown are acceptable.
2. Adequate clearance must be provided for the washer size selected.
3. See discussion below regarding the use of alternate 1$\frac{1}{16}$-in. hole size for ¾-in.-diameter anchor rods, with plates less than 1¼ in. thick.

Galvanized anchor rods are often used when the column-base-plate assembly is exposed and subject to corrosion. Either the hot-dip galvanizing process (ASTM 153) or the mechanical galvanizing process (ASTM B695) is allowed in ASTM F1554; however, all threaded components of the fastener assembly must be galvanized by the same process. Mixing of rods galvanized by one process and nuts by another may result in an unworkable assembly. It is recommended that galvanized anchor rods and nuts be purchased from the same supplier and shipped preassembled. Because this is not an ASTM requirement, this should be specified on the contract documents.

Note also that galvanizing increases friction between the nut and the rod and even though the nuts are over tapped, special lubrication may be required.

ASTM A449, A36 and A307 specifications are listed in Table 2.2 for comparison purposes, because some suppliers are more familiar with these specifications. Note that ASTM F1554 grades match up closely with many aspects of these older material specifications. Note also that these older material specifications contain almost none of the anchor rod specific requirements found in ASTM F1554.

Drilled-in epoxy-type anchor rods are discussed in several places in this Design Guide. This category of anchor rod does not include wedge-type mechanical anchors, which are not recommended for anchor rods because they must be tensioned to securely lock in the wedge device. Column movement during erection can cause wedge-type anchor rods to loosen.

2.6 Anchor Rod Holes and Washers

The most common field problem is anchor rod placements that either do not fit within the anchor rod hole pattern or do not allow the column to be properly positioned. Because OSHA requires any modification of anchor rods to be approved by the Engineer of Record, it is important to provide as large a hole as possible to accommodate setting tolerances. The AISC-recommended hole sizes for anchor rods are given in Table 2.3.

These hole sizes originated in the first edition of Design Guide 1, based on field problems in achieving the column setting tolerances required for the previous somewhat smaller recommended sizes. They were later included in the AISC *Steel Construction Manual*.

The washer diameters shown in Table 2.3 are sized to cover the entire hole when the anchor rod is located at the edge of the hole. Plate washers are usually custom fabricated by thermal cutting the shape and holes from plate or bar stock. The washer may be either a plain circular washer or a rectangular plate washer as long as the thickness is adequate to prevent pulling through the hole. The plate washer thicknesses shown in the table are similar to the recommendation in Design Guide 7, that the washer thickness be approximately one-third the anchor rod diameter. The same thickness is adequate for all grades of ASTM F1554, since the pull-through criterion requires appropriate stiffness as well as strength.

For anchor rods for columns designed for axial compression only, the designer may consider using a smaller hole diameter of 1$\frac{1}{16}$ in. with ¾-in.-diameter rods and base plates less than 1¼ in. thick, as allowed in Footnote 3 in Table 2.3. This will allow the holes to be punched up to this plate thickness, and the use of ASTM F844 (USS Standard) washers in lieu of the custom washers of dimensions shown in the table. This potential fabrication savings must be weighed against possible problems with placement of anchor rods out of tolerance.

For anchor rods designed to resist moment or axial tension, the hole and washer sizes recommended in Table 2.3 should be used. The added setting tolerance is especially important when the full or near-full strength of the rod in tension is needed for design purposes, because almost any field fix in this case will be very difficult.

Additional recommendations regarding washers and anchor rod holes are as follows:

- Washers should not be welded to the base plate, except when the anchor rods are designed to resist shear at the column base (see Section 3.5).
- ASTM F436 washers are not used on anchor rods because they generally are of insufficient size.
- Washers for anchor rods are not, and do not need to be, hardened.

2.7 Anchor Rod Sizing and Layout

Use ¾-in.-diameter ASTM F1554 Grade 36 rod material whenever possible. Where more strength is required, consider increasing rod diameter up to about 2 in. in ASTM F1554 Grade 36 material before switching to a higher-strength material grade.

Anchor rod details should always specify ample threaded length. Whenever possible, threaded lengths should be specified at least 3 in. greater than required, to allow for variations in setting elevation.

Anchor rod layouts should, where possible, use a symmetrical pattern in both directions and as few different layouts as possible. Thus, the typical layout should have four anchor rods in a square pattern.

Anchor rod layouts should provide ample clearance distance for the washer from the column shaft and its weld, as well as a reasonable edge distance. When the hole edge is not subject to a lateral force, even an edge distance that provides a clear dimension as small as ½ in. of material from the edge of the hole to the edge of the plate will normally suffice, although field issues with anchor rod placement may necessitate a larger dimension to allow some slotting of the base plate holes. When the hole edge is subject to a lateral force, the edge distance provided must be large enough for the necessary force transfer.

Keep the construction sequence in mind when laying out anchor rods adjacent to walls and other obstructions. Make sure the erector will have the access necessary to set the column and tighten the nuts on the anchor rods. Where special settings are required at exterior walls, moment bases, and other locations, clearly identify these settings on both the column schedule and foundation drawings.

Anchor rod layouts must be coordinated with the reinforcing steel to ensure that the rods can be installed in the proper location and alignment. This is especially critical in concrete piers and walls where there is less room for adjustment in the field. Anchor rods in piers should never extend below the bottom of the pier into the footing because this would require that the anchor rods be partially embedded prior to forming the pier, which makes it almost impossible to maintain alignment. When the pier height is less than the required anchor rod embedment length, the pier should be eliminated and the column extended to set the base plate on the footing.

2.8 Anchor Rod Placement and Tolerances

Proper placement of anchor rods provides for the safe, fast, and economical erection of the structural steel frame.

The placement process begins with the preparation of an anchor rod layout drawing. While it is possible to lay out anchor rods using the foundation design drawings and the column schedule, there will be fewer problems if the structural steel detailer coordinates all anchor rod details with the column-base-plate assembly. The anchor rod layout drawing will show all anchor rod marks along with layout dimensions and elevation requirements. Because of schedule pressures, there is sometimes a rush to set anchor rods using a drawing submitted for approval. This should be avoided; only placement drawings that have been designated as "Released for Construction" should be used for this important work.

Layout (and after-placement surveying) of all anchor rods should be done by an experienced construction surveyor. The surveyor should be able to read structural drawings and knowledgeable of construction practices. A typical licensed land surveyor may or may not have the necessary knowledge and experience for this type of work.

Templates should be made for each anchor rod setting pattern. Typically, templates are made of plywood on site. The advantage of plywood templates is they are relatively inexpensive to make and are easy to fasten in place to the wood foundation forms. The anchor rods can be held securely in place and relatively straight by using a nut on each side of the template. Steel templates consisting of flat plates or angle-type frames are sometimes used for very large anchor rod assemblies requiring close setting tolerances. Provisions should be made to secure the template in place, such as with nailing holes provided in the steel plate. Steel plate templates can also be reused as setting plates.

Embedded templates are sometimes used with large anchor rod assemblies to help maintain alignment of the rods during concrete placement. The template should be kept as small as possible to avoid interference with the reinforcing steel and concrete placement. When using a single exposed template, the reinforcing steel can be placed before positioning the anchor rods in the form. With the embedded template, the anchor rod assembly must be placed first and the reinforcing steel placed around or though the template. Care must be taken to consolidate the concrete around the tem-

Note: Anchor rods size and layout based on OSHA requirements based on connection type

> ***OSHA Requirements***
>
> The regulations of the Occupational Safety and Health Administration (OSHA) *Safety Standards for Steel Erection* (OSHA, 2001) require a minimum of four anchor rods in column-base-plate connections. The requirements exclude post-type columns that weigh less than 300 lb. Columns, base plates, and their foundations must have sufficient moment strength to resist a minimum eccentric gravity load of 300 lb located 18 in. from the extreme outer face of the column in each direction.
>
> The OSHA criteria can be met with even the smallest of anchor rods on a 4-in. × 4-in. pattern. If one considers only the moments from the eccentric loads (since including the gravity loads results in no tensile force in the anchor rods), and the resisting force couple is taken as the design force of the two bolts times a 4-in. lever arm, the design moment strength for ¾-in. anchor rods equals (2)(19.1 kips)(4 in.) = 306 kip-in. For a 14-in.-deep column, the OSHA required moment strength is only (1.6)(0.300)(18 + 7) = 12.0 kip-in.

Base Plates:

Material:	ASTM A36 Steel
Side Length:	Column Nominal Depth plus 6”
Thickness:	Pin: ¾” Moment: $1\frac{5}{8}$”

** Thickness Calculation based on Chapter 3 of Base Plate and Anchor Rod Steel Design Guide

Table 2.1. Base Plate Materials

Thickness (t_p)	Plate Availability
$t_p \leq 4$ in.	ASTM A36 [a] ASTM A572 Gr 42 or 50 ASTM A588 Gr 42 or 50
4 in. < $t_p \leq 6$ in.	ASTM A36 [a] ASTM A572 Gr 42 ASTM A588 Gr 42
$t_p > 6$ in.	ASTM A36

[a] Preferred material specification

The vast majority of building columns are designed for axial compression only with little or no uplift. For such columns, the simple column-base-plate connection detail shown in Figure 1.1 is sufficient. The design of column-base-plate connections for axial compression only is presented in Section 3. The design is simple and need not be encumbered with many of the more complex issues discussed in Appendix A, which pertains to special structures. Anchor rods for gravity columns are often not required for the permanent structure and need only be sized to provide for column stability during erection.

Column base plate connections are also capable of transmitting uplift forces and can transmit shear through the anchor rods if required. If the base plate remains in compression, shear can be transmitted through friction against the grout pad or concrete; thus, the anchor rods are not required to be designed for shear. Large shear forces can be resisted by bearing against concrete, either by embedding the column base or by adding a shear lug under the base plate.

Column base plate moment connections can be used to resist wind and seismic loads on the building frame. Moment at the column base can be resisted by development of a force couple between bearing on the concrete and tension in some or all of the anchor rods.

This guide will enable the designer to design and specify economical column base plate details that perform adequately for the specified demand. The objective of the design process in this Guide is that under service loading and under extreme loading in excess of the design loads, the behavior of column base plates should be close to that predicted by the approximate mathematical equations in this Design Guide.

Historically, two anchor rods have been used in the area bounded by column flanges and web. Recent regulations of the U.S. Occupational Safety and Health Administration (OSHA) *Safety Standards for Steel Erection* (OSHA, 2001) (Subpart R of 29 CFR Part 1926) require four anchor rods in almost all column-base-plate connections and require all columns to be designed for a specific bending moment to reflect the stability required during erection with an ironworker on the column. This regulation has essentially eliminated the typical detail with two anchor rods except for small post-type structures that weigh less than 300 lb (e.g., doorway portal frames).

This Guide supersedes the original AISC Design Guide 1, *Column Base Plates*. In addition to the OSHA regulations, there has been significant research and improved design guidelines issued subsequent to the publication of Design Guide 1 in 1990. The ACI *Building Code Requirements for Structural Concrete* (ACI, 2002) has improved provisions for the pullout and breakout strength of anchor rods and other embedded anchors. Design guidance for anchor rods based on the ACI recommendations is included, along with practical suggestions for detailing and installing anchor rod assemblies. These guidelines deal principally with cast-in-place anchors and with their design, installation, inspection, and repair in column-base-plate connections.

The AISC Design Guide 7, 2nd edition, *Industrial Buildings: Roofs to Column Anchorage* (Fisher, 2004), contains additional examples and discussion relative to the design of anchor rods.

2.0 MATERIALS, FABRICATION, INSTALLATION, AND REPAIRS

2.1 Material Specifications

The AISC Specification lists a number of plate and threaded rod materials that are structurally suitable for use in base plate and anchor rod designs. Based on cost and availability, the materials shown in Tables 2.1 and 2.2 are recommended for typical building design.

2.2 Base Plate Material Selection

Base plates should be designed using ASTM A36 material unless the availability of an alternative grade is confirmed

Table 2.2. Anchor Rod Materials							
Material ASTM		Tensile Strength, F_u (ksi)	Nominal Tensile Stress,[a] $F_{nt} = 0.75F_u$ (ksi)	Nominal Shear Stress (X type),[a, b] $F_{nv} = 0.50F_u$ (ksi)	Nominal Shear Stress (N type),[a, c] $F_{nv} = 0.40F_u$ (ksi)	Maximum Diameter, in.
F1554	Gr 36 [d]	58	43.5	29.0	23.2	4
	Gr 55	75	56.3	37.5	30.0	4
	Gr 105	125	93.8	62.5	50.0	3
A449		120	90.0	60.0	48.0	1
		105	78.8	57.5	42.0	1½
		90	67.5	45.0	36.0	3
A36		58	43.5	29.0	23.2	4
A307		58	43.5	29.0	23.2	4
A354 Gr BD		150	112	75.0	60.0	2½
		140	105	70.0	56.0	4

[a] Nominal stress on unthreaded body for cut threads (based on major thread diameter for rolled threads)
[b] Threads excluded from shear plane
[c] Threads included in the shear plane
[d] Preferred material specification

prior to specification. Since ASTM A36 plate is readily available, the plates can often be cut from stock material. There is seldom a reason to use high-strength material, since increasing the thickness will provide increased strength where needed. Plates are available in ⅛-in. increments up to 1¼ in. thickness and in ¼-in. increments above this. The base plate sizes specified should be standardized during design to facilitate purchasing and cutting of the material.

When designing base plate connections, it is important to consider that material is generally less expensive than labor and, where possible, economy may be gained by using thicker plates rather than detailing stiffeners or other reinforcement to achieve the same strength with a thinner base plate. A possible exception to this rule is the case of moment-type bases that resist large moments. For example, in the design of a crane building, the use of a seat or stool at the column base may be more economical, if it eliminates the need for large complete-joint-penetration (CJP) groove welds to heavy plates that require special material specifications.

Most column base plates are designed as square to match the foundation shape and more readily accommodate square anchor rod patterns. Exceptions to this include moment-resisting bases and columns that are adjacent to walls.

Many structural engineers have established minimum thicknesses for typical gravity columns. For posts and light HSS columns, the minimum plate thickness is typically ½ in., and for other structural columns a plate thickness of ¾ in. is commonly accepted as the minimum thickness specified.

2.3 Base Plate Fabrication and Finishing

Typically, base plates are thermally cut to size. Anchor rod and grout holes may be either drilled or thermally cut. Section M2.2 of the AISC Specification lists requirements for thermal cutting as follows:

"...thermally cut free edges that will be subject to calculated static tensile stress shall be free of round-bottom gouges greater than 3/16 in. deep ... and sharp V-shaped notches. Gouges deeper than 3/16 in. ... and notches shall be removed by grinding and repaired by welding."

Because free edges of the base plate are not subject to tensile stress, these requirements are not mandatory for the perimeter edges; however, they provide a workmanship guide that can be used as acceptance criteria. Anchor rod holes, which may be subject to tensile stress, should meet the requirements of Section M2.2. Generally, round-bottom grooves within the limits specified are acceptable, but sharp notches must be repaired. Anchor rod hole sizes and grouting are covered in Sections 2.6 and 2.10 of this design guide.

Finishing requirements for column bases on steel plates are covered in Section M2.8 of the AISC Specification as follows:

"Steel bearing plates 2 in. ... or less in thickness are permitted without milling, provided a satisfactory contact bearing is obtained. Steel bearing plates over 2 in. ... but not over 4 in. ... in thickness are permitted to be straightened by press-

For example, in statically loaded structures, if the strength is much larger than the demand, the ductility is not necessary and it is acceptable to design with the limit state of tensile or shear strength of the anchor rod group governing the design. However, frames designed for seismic lateral load resistance are expected to behave in a ductile manner and, in this case, it may be necessary to design the foundation and the column-base-plate connection so that the concrete limit states of tensile or shear strength of the anchor rod group do not govern the design. See ACI Appendix D, Section D3.3.4.

OSHA Requirements

The regulations of the Occupational Safety and Health Administration (OSHA) *Safety Standards for Steel Erection* (OSHA, 2001) require a minimum of four anchor rods in column-base-plate connections. The requirements exclude post-type columns that weigh less than 300 lb. Columns, base plates, and their foundations must have sufficient moment strength to resist a minimum eccentric gravity load of 300 lb located 18 in. from the extreme outer face of the column in each direction.

The OSHA criteria can be met with even the smallest of anchor rods on a 4-in. × 4-in. pattern. If one considers only the moments from the eccentric loads (since including the gravity loads results in no tensile force in the anchor rods), and the resisting force couple is taken as the design force of the two bolts times a 4-in. lever arm, the design moment strength for ¾-in. anchor rods equals (2)(19.1 kips)(4 in.) = 306 kip-in. For a 14-in.-deep column, the OSHA required moment strength is only (1.6)(0.300)(18 + 7) = 12.0 kip-in.

3.1. Concentric Compressive Axial Loads

When a column base resists only compressive column axial loads, the base plate must be large enough to resist the bearing forces transferred from the base plate (concrete bearing limit), and the base plate must be of sufficient thickness (base plate yielding limit).

3.1.1 Concrete Bearing Limit

The design bearing strength on concrete is defined in ACI 318-02, Section 10.17, as $\phi(0.85f_c'A_1)$ when the supporting surface is not larger than the base plate. When the supporting surface is wider on all sides than the loaded area, the design bearing strength above is permitted to be multiplied by $\sqrt{A_2/A_1} \leq 2$.

The 2005 AISC Specification, Section J8, provides the nominal bearing strength, P_p, as follows:

Equation J8-1:

$P_p = 0.85f_c'A_1$ on the full area of a concrete support.

Equation J8-2:

$$P_p = \left(0.85f_c'A_1\right)\left(\sqrt{\frac{A_2}{A_1}}\right) \leq 1.7f_c'A_1$$

These equations are multiplied by the resistance factor, ϕ, for LRFD or divided by the safety factor, Ω, for ASD. Section J8 stipulates the ϕ and Ω factors (in the absence of Code Regulations) for bearing on concrete as follows:

$$\phi = 0.60 \text{ (LRFD)} \qquad \Omega = 2.50 \text{ (ASD)}$$

Alternatively, ACI 318-02 stipulates a ϕ factor of 0.65 for bearing on concrete. This apparent conflict exists due to an oversight in the AISC Specification development process. The authors recommend the use of the ACI-specified ϕ factor in designing column base plates.

The nominal bearing strength can be converted to a stress format by dividing out the area term P_p equations such that,

On the full area of a concrete support:

$$f_{p(max)} = 0.85f_c'$$

When the concrete base is larger than the loaded area on all four sides:

$$f_{p(max)} = \left(0.85f_c'\right)\left(\sqrt{\frac{A_2}{A_1}}\right) \leq 1.7f_c'$$

The conversion of the generic nominal pressure to an LRFD or ASD available bearing stress is

$$f_{pu(max)} = \phi f_{p(max)} \text{ (LRFD)}$$

$$f_{pa(max)} = \frac{f_{p(max)}}{\Omega} \text{ (ASD)}$$

The concrete bearing strength is a function of the concrete compressive strength, and the ratio of geometrically similar concrete area to base plate area, as indicated in Section 10.17 of ACI 318 (ACI, 2002), as follows:

$$f_{p(max)} = \phi\left(0.85f_c'\right)\sqrt{\frac{A_2}{A_1}}$$

$$\sqrt{\frac{A_2}{A_1}} \leq 2$$

where

$f_{p(max)}$ = maximum concrete bearing stress, ksi

ϕ = strength reduction factor for bearing, 0.65 per Section 9.3, ACI 318-02

f_c' = specified compressive strength of concrete, ksi

A_1 = area of the base plate, in.[2]

A_2 = maximum area of the portion of the supporting surface that is geometrically similar to and concentric with the loaded area, in.[2]

The increase of the concrete bearing capacity associated with the term $\sqrt{A_2/A_1}$ accounts for the beneficial effects of the concrete confinement. Note that A_2 is the largest area that is geometrically similar to (having the same aspect ratio as) the base plate and can be inscribed on the horizontal top surface of the concrete footing, pier, or beam without going beyond the edges of the concrete.

There is a limit to the beneficial effects of confinement, which is reflected by the limit on A_2 (to a maximum of four times A_1) or by the inequality limit. Thus, for a column base plate bearing on a footing far from edges or openings, $\sqrt{A_2/A_1} = 2$.

The bearing stress on the concrete must not be greater than $f_{p(max)}$:

$$\frac{P_u}{A_1} \leq f_{pu(max)} \text{ (LRFD)}$$

$$\frac{P_a}{A_1} \leq f_{pa(max)} \text{ (ASD)}$$

Thus,

$$A_{1(req)} = \frac{P_u}{f_{pu(max)}} \text{ (LRFD)}$$

$$A_{1(req)} = \frac{P_a}{f_{pa(max)}} \text{ (ASD)}$$

When $A_2 = A_1$, the required minimum base plate area can be determined as

$$A_{1(req)} = \frac{P_u}{\phi 0.85 f_c'} \text{ (LRFD)}$$

$$A_{1(req)} = \frac{\Omega P_a}{0.85 f_c'} \text{ (ASD)}$$

When $A_2 \geq 4A_1$, the required minimum base plate area can be determined as

$$A_{1(req)} = \frac{1}{2}\left(\frac{P_u}{\phi 0.85 f_c'}\right) \text{ (LRFD)}$$

$$A_{1(req)} = \frac{1}{2}\left(\frac{\Omega P_a}{0.85 f_c'}\right) \text{ (ASD)}$$

Many column base plates bear directly on a layer of grout. Because, the grout compressive strength is always specified higher than the concrete strength—the authors recommend that the grout strength be specified as two times the concrete strength—it is conservative to use the concrete compressive strength for f_c' in the above equations.

The important dimensions of the column-base plate connection are shown in Figure 3.1.1.

3.1.2 Base Plate Yielding Limit (W-Shapes)

For axially loaded base plates, the bearing stress under the base plate is assumed uniformly distributed and can be expressed as

$$f_{pu} = \frac{P_u}{BN} \text{ (LRFD)}$$

$$f_{pa} = \frac{P_a}{BN} \text{ (ASD)}$$

This bearing pressure causes bending in the base plate at the assumed critical sections shown in Figure 3.1.1(b). This

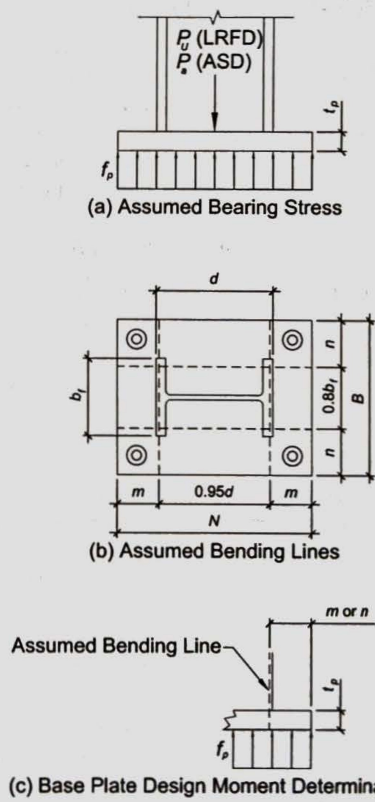


Figure 3.1.1. Design of base plate with axial compressive load.

bearing pressure also causes bending in the base plate in the area between the column flanges (Thornton, 1990; Drake and Elkin, 1999). The following procedure allows a single procedure to determine the base plate thickness for both situations.

The required strength of the base plate can be determined as

$$M_{pl} = f_{pu}\left(\frac{l^2}{2}\right) \text{ (LRFD)}$$

$$M_{pl} = f_{pa}\left(\frac{l^2}{2}\right) \text{ (ASD)}$$

Where the critical base plate cantilever dimension, l, is the larger of m, n, and $\lambda n'$,

$$m = \frac{N - 0.95d}{2}$$

$$n = \frac{B - 0.8b_f}{2}$$

$$\lambda n' = \lambda \frac{\sqrt{db_f}}{4}$$

N = base plate length, in.

B = base plate width, in.

b_f = column flange width, in.

d = overall column depth, in.

n' = yield-line theory cantilever distance from column web or column flange, in.

$$\lambda = \frac{2\sqrt{X}}{1+\sqrt{1-X}} \le 1$$

$$X = \left\{\frac{4db_f}{(d+b_f)^2}\right\}\frac{P_u}{\phi_c P_p} \text{ (LRFD)}$$

$$X = \left\{\frac{4db_f}{(d+b_f)^2}\right\}\frac{\Omega_c P_a}{P_p} \text{ (ASD)}$$

where

P_u = the required axial compressive load (LRFD), kips

P_a = the required axial compressive load (ASD), kips

$$P_p = 0.85 f'_c A_1 \sqrt{\frac{A_2}{A_1}}$$

It is conservative to take λ as 1.0.

For the yielding limit state, the required minimum thickness of the base plate can be calculated as follows (Thornton, 1990) (AISC, 2005):

$$t_{min} = l\sqrt{\frac{2P_u}{\phi F_y BN}} \text{ (LRFD)}$$

$$t_{min} = l\sqrt{\frac{2\Omega P_a}{F_y BN}} \text{ (ASD)}$$

where

ϕ = resistance factor for flexure, 0.90

Ω = factor of safety for ASD, 1.67

F_y = specified minimum yield stress of base plate, ksi

Since l is the maximum value of m, n, and $\lambda n'$, the thinnest base plate can be found by minimizing m, n, and λ. This is usually accomplished by proportioning the base plate dimensions so that m and n are approximately equal.

3.1.3 Base Plate Yielding Limit (HSS and Pipe)

For HSS columns, adjustments for m and n must be made (DeWolf and Ricker, 1990). For rectangular HSS, both m and n are calculated using yield lines at 0.95 times the depth and width of the HSS. For round HSS and Pipe, both m and n are calculated using yield lines at 0.8 times the diameter. The λ term is not used for HSS and Pipe.

3.1.4 General Design Procedure

Three general cases exist for the design of base plates subject to axial compressive loads only:

Case I: $A_2 = A_1$
Case II: $A_2 \ge 4A_1$
Case III: $A_1 < A_2 < 4A_1$

The most direct approach is to conservatively set A_2 equal to A_1 (Case I); however, this generally results in the largest base plate plan dimensions. The smallest base plate plan dimensions occur when the ratio of the concrete to base plate area is larger than or equal to 4, i.e., $A_2 \ge 4A_1$ (Case II). Base plates resting on piers often meet the case that A_2 is larger than A_1 but less than $4A_1$, which leads to Case III.

When a base plate bears on a concrete pedestal larger than the base plate dimension, the required minimum base plate area cannot be directly determined. This is because both A_1 and A_2 are unknown.

As mentioned before, the most economical base plates usually occur when m and n, shown in Figure 3.1.1(b), are equal. This situation occurs when the difference between B and N is equal to the difference between $0.95d$ and $0.8b_f$.

In selecting the base plate size from a strength viewpoint, the designer must consider the location of the anchor rods within the plate and the clearances required to tighten the bolts on the anchor rods.

Steps for obtaining base plates sizes for these cases are suggested below. Anchor rod design is covered in Section 3.2.

Case I: $A_2 = A_1$

The largest base plate is obtained when $A_2 = A_1$.

1. Calculate the required axial compressive strength, P_u (LRFD) or P_a (ASD).

2. Calculate the required base plate area.

$$A_{1(req)} = \frac{P_u}{\phi 0.85 f_c'} \text{ (LRFD)}$$

$$A_{1(req)} = \frac{\Omega P_a}{0.85 f_c'} \text{ (ASD)}$$

3. Optimize the base plate dimensions, N and B.

$$N \approx \sqrt{A_{1(req)}} + \Delta$$

where $\Delta = \dfrac{0.95d - 0.8b_f}{2}$

then

$$B = \frac{A_{1(req)}}{N}$$

Note that the base plate holes are not deducted from the base plate area when determining the required base plate area. As mentioned earlier in the Guide, from a practical view point set N equal to B.

4. Calculate the required base plate thickness.

$$m = \frac{N - 0.95d}{2}$$

$$n = \frac{B - 0.8b_f}{2}$$

$$\lambda n' = \lambda \frac{\sqrt{db_f}}{4}$$

N = base plate length, in.

B = base plate width, in.

b_f = column flange width, in.

d = overall column depth, in.

n' = yield-line theory cantilever distance from column web or column flange, in.

$$\lambda = \frac{2\sqrt{X}}{1 + \sqrt{1 - X}} \le 1$$

$$X = \left\{ \frac{4db_f}{(d + b_f)^2} \right\} \frac{P_u}{\phi P_p} \text{ (LRFD)}$$

$$X = \left\{ \frac{4db_f}{(d + b_f)^2} \right\} \frac{\Omega P_a}{P_p} \text{ (ASD)}$$

where

$$\phi P_p = \phi 0.85 f_c' A_1 \text{ (LRFD)}$$

$$\frac{P_p}{\Omega} = \frac{0.85 f_c' A_1}{\Omega} \text{ (ASD)}$$

Find l_{max} $(m, n, \lambda n')$

$$t_{min} = l \sqrt{\frac{2P_u}{\phi F_y BN}} \text{ (LRFD)}$$

$$t_{min} = l \sqrt{\frac{2P_a \Omega}{F_y BN}} \text{ (ASD)}$$

5. Determine the anchor rod size and the location of the anchor rods. Anchor rods for gravity columns are generally not required for the permanent structure and need only to be sized for OSHA requirements and practical considerations.

Case II: $A_2 \ge 4A_1$

The smallest base plate is obtained when $A_2 \ge 4A_1$ for this case.

1. Calculate the factored axial compressive load, P_u (LRFD) or P_a (ASD).

2. Calculate the required base plate area.

$$A_{1(req)} = \frac{P_u}{2\phi 0.85 f_c'} \text{ (LRFD)}$$

$$A_{1(req)} = \frac{\Omega P_a}{2(0.85 f'_c)} \text{ (ASD)}$$

3. Optimize the base plate dimensions, N and B.

   Use the same procedure as in Step 3 from Case I.

4. Check if sufficient area, A_2 exists for Case II applicability ($A_2 \geq 4A_1$).

   Based on the pier or footing size, it will often be obvious if the condition is satisfied. If it is not obvious, calculate A_2 geometrically similar to A_1. With new dimensions N_2 and B_2, A_2 then equals $(N_2)(B_2)$. If $A_2 \geq 4A_1$, calculate the required thickness using the procedure shown in Step 4 of Case I, except that

$$\phi P_p = \phi f'_c 2A_1 \text{ (LRFD)}$$

$$\frac{P_p}{\Omega} = \frac{f'_c 2A_1}{\Omega} \text{ (ASD)}$$

5. Determine the anchor rod size and location.

Case III: $A_1 < A_2 < 4A_1$

1. Calculate the factored axial compressive load, P_u (LRFD) or P_a (ASD).

2. Calculate the approximate base plate area based on the assumption of Case III.

$$A_{1(req)} = \frac{P_u}{2\phi 0.85 f'_c} \text{ (LRFD)}$$

$$A_{1(req)} = \frac{\Omega P_a}{2(0.85 f'_c)} \text{ (ASD)}$$

3. Optimize the base plate dimensions, N and B.

   Use the same procedure as in Step 3 from Case I.

4. Calculate A_2, geometrically similar to A_1.

5. Determine whether

$$P_u \leq \phi P_p = \phi 0.85 f'_c A_1 \sqrt{\frac{A_2}{A_1}} \text{ (LRFD)}$$

$$P_a \leq \frac{P_p}{\Omega} = \left(\frac{0.85 f'_c A_1}{\Omega}\right)\sqrt{\frac{A_2}{A_1}} \text{ (ASD)}$$

   If the condition is not satisfied, revise N and B, and retry until criterion is satisfied.

6. Determine the base plate thickness using Step 4, as shown in Case I.

7. Determine the anchor rod size, and their locations.

3.2 Tensile Axial Loads

The design of anchor rods for tension consists of four steps:

1. Determine the maximum net uplift for the column.

2. Select the anchor rod material and the number and size of anchor rods required to resist uplift.

3. Determine the appropriate base plate size, thickness, and welding to transfer the uplift forces.

4. Determine the method for developing the strength of the anchor rod in the concrete (i.e., transferring the tension force from the anchor rod to the concrete foundation).

Step 1—The maximum net uplift for the column is obtained from the structural analysis of the building for the prescribed building loads. When the uplift due to wind exceeds the dead load of a roof, the supporting columns are subjected to net uplift forces. In addition, columns in rigid bents or braced bays may be subjected to net uplift forces due to overturning.

Step 2—Anchor rods should be specified to conform to the material discussed in Section 2.5. The number of anchor rods required is a function of the maximum net uplift on the column and the strength per rod for the anchor rod material chosen.

Prying forces in anchor rods are typically neglected. This is usually justified when the base plate thickness is calculated assuming cantilever bending about the web and/or flange of the column section (as described in Step 3 below), and because the length of the rods result in larger deflections than for steel to steel connections. The procedure to determine the required size of the anchor rods is discussed in Section 3.2.1 below.

Step 3—Base plate thickness may be governed by bending associated with compressive or tensile loads.

For tensile loads, a simple approach is to assume the anchor rod loads generate bending moments in the base plate consistent with cantilever action about the web or flanges of the column section (one-way bending). See Figure 3.1.1. If the web is taking the anchor load from the base plate, the web and its attachment to the base plate should be checked. Alternatively, a more refined base plate analysis for anchor rods positioned inside the column flanges can be used to consider bending about both the web and the column flanges (two-way bending). For the two-way bending approach, the derived bending moments should be consistent with com-

The available strength, per unit width, of the plate is

$$\phi_b R_n = \phi_b F_y \frac{t_p^2}{4} \text{ (LRFD)} \qquad (3.3.13a)$$

$$\frac{R_n}{\Omega} = \frac{F_y}{\Omega}\frac{t_p^2}{4} \text{ (ASD)} \qquad (3.3.13b)$$

where

ϕ_b = strength reduction factor in bending = 0.90

Ω = the safety factor in bending =1.67

To determine the plate thickness, equate the right-hand sides of Equations 3.3.11 or 3.3.12 and 3.3.13 and solve for $t_{p(req)}$:

For $Y \geq m$:

$$t_{p(req)} = \sqrt{\frac{4\left[f_p\left(\frac{m^2}{2}\right)\right]}{0.90F_y}} = 1.5m\sqrt{\frac{f_p}{F_y}} \text{ (LRFD)} \qquad (3.3.14a)$$

$$t_{p(req)} = \sqrt{\frac{4\left[f_p\left(\frac{m^2}{2}\right)\right]}{F_y/1.67}} = 1.83m\sqrt{\frac{f_p}{F_y}} \text{ (ASD)} \qquad (3.3.14b)$$

For $Y < m$:

$$t_{p(req)} = 2.11\sqrt{\frac{f_p Y\left(m - \frac{Y}{2}\right)}{F_y}} \text{ (LRFD)} \qquad (3.3.15a)$$

$$t_{p(req)} = 2.58\sqrt{\frac{f_p Y\left(m - \frac{Y}{2}\right)}{F_y}} \text{ (ASD)} \qquad (3.3.15b)$$

where

$t_{p(req)}$ = minimum plate thickness

Note: When n is larger than m, the thickness will be governed by n. To determine the required thickness, substitute n for m in Equations 3.3.14, and 3.3.15. While this approach offers a simple means of designing the base plate for bending, when the thickness of the plate is controlled by n, the designer may choose to use other methods of designing the plate for flexure, such as yield-line analysis or a triangular pressure distribution assumption, as discussed in Appendix B.

3.3.3 Base Plate Flexural Yielding at Tension Interface

With the moment such that $e \leq e_{crit}$, there will be no tension in the anchor rods and thus they will not cause bending in the base plate at the tension interface. Therefore, bearing at the interface will govern the design of the base plate thickness.

3.3.4 General Design Procedure

1. Determine the axial load and moment.
2. Pick a trial base plate size, $N \times B$.
3. Determine the equivalent eccentricity,

$$e = M_r/P_r,$$

and the critical eccentricity,

$$e_{crit} = \frac{N}{2} - \frac{P_r}{2q_{max}}$$

If $e \leq e_{crit}$, go to next step (design of the base plate with small moment); otherwise, refer to design of the base plate with large moment (Section 3.4).

4. Determine the bearing length, Y.
5. Determine the required minimum base plate thickness $t_{p(req)}$.
6. Determine the anchor rod size.

3.4 Design of Column Base Plates with Large Moments

When the magnitude of the bending moment is large relative to the column axial load, anchor rods are required to connect the base plate to the concrete foundation so that the base does not tip nor fail the concrete in bearing at the compressed edge. This is a common situation for rigid frames designed to resist lateral earthquake or wind loadings and is schematically presented in Figure 3.4.1.

As discussed in the previous section, large moment conditions exist when

$$e > e_{crit} = \frac{N}{2} - \frac{P_r}{2q_{max}} \qquad (3.3.1)$$

3.4.1 Concrete Bearing and Anchor Rod Forces

The bearing pressure, q, is equal to the maximum value, q_{max}, for eccentricities greater than e_{crit}. To calculate the total concrete bearing force and the anchor rod forces, consider the force diagram shown in Figure 3.4.1.

Vertical force equilibrium requires that

$$\sum F_{vertical} = 0$$

$$T = q_{max}Y - P_r \tag{3.4.2}$$

where T equals the anchor rod required tensile strength.

Also, the summation of moments taken about the point B must equal zero. Hence,

$$q_{max}Y\left(\frac{N}{2} - \frac{Y}{2} + f\right) - P_r(e+f) = 0$$

After rearrangement, a quadratic equation for the bearing length, Y, is obtained:

$$Y^2 - 2\left(\frac{N}{2} + f\right)Y + \frac{2P_r(e+f)}{q_{max}} = 0$$

and the solution for Y is

$$Y = \left(f + \frac{N}{2}\right) \pm \sqrt{\left(f + \frac{N}{2}\right)^2 - \frac{2P_r(e+f)}{q_{max}}} \tag{3.4.3}$$

The concrete bearing force is given by the product $q_{max}Y$. The anchor rod tensile force, T, is obtained by solving Equation 3.4.2.

For certain force, moment, and geometry combinations, a real solution of Equation 3.4.3 is not possible. In that case, an increase in plate dimensions is required. In particular, only if the following holds

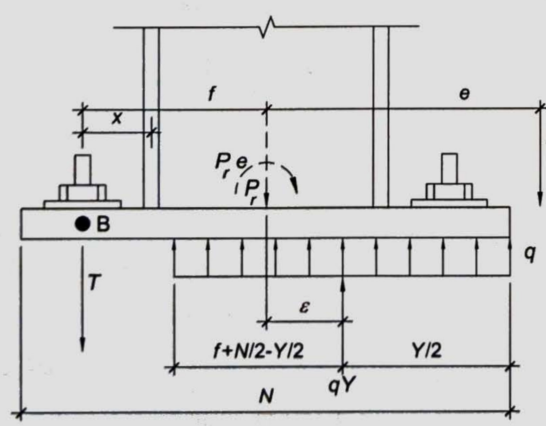


Figure 3.4.1. Base plate with large moment.

$$\left(f + \frac{N}{2}\right)^2 \geq \frac{2P_r(e+f)}{q_{max}} \tag{3.4.4}$$

will the quantity under the radical in Equation 3.4.3 be positive or zero and provide a real solution. If the expression in Equation 3.4.4 is not satisfied, a larger plate is required.

Substitution of the critical value of e from Equation 3.3.7 into Equation 3.4.3 results in the following expression for Y:

$$Y = \left(f + \frac{N}{2}\right) \pm \sqrt{\left(f + \frac{N}{2}\right)^2 - \frac{2P_r\left[f + \left(\frac{N}{2} - \frac{P_r}{2q_{max}}\right)\right]}{q_{max}}}$$

Rearranging terms:

$$Y = \left(f + \frac{N}{2}\right) \pm \sqrt{\left(f + \frac{N}{2}\right)^2 - \frac{2P_r}{q_{max}}\left(f + \frac{N}{2}\right) + \left(\frac{P_r}{q_{max}}\right)^2}$$

$$= \left(f + \frac{N}{2}\right) \pm \left[\left(f + \frac{N}{2}\right) - \frac{P_r}{q_{max}}\right]$$

Finally, use of the negative sign before the last term gives the value for Y:

$$Y = \frac{P_r}{q_{max}}$$

3.4.2 Base Plate Yielding Limit at Bearing Interface

For the case of large moments, the bearing stress is at its limiting value:

$$f_p = f_{p(max)}$$

The required plate thickness may be determined from either Equation 3.3.14 or 3.3.15:

If $Y \geq m$:

$$t_{p(req)} = 1.5m\sqrt{\frac{f_{p(max)}}{F_y}} \text{ (LRFD)} \tag{3.3.14a}$$

$$t_{p(req)} = 1.83m\sqrt{\frac{f_{p(max)}}{F_y}} \text{ (ASD)} \tag{3.3.14b}$$

If $Y < m$:

$$t_{p(req)} = 2.11\sqrt{\frac{f_{p(max)}Y\left(m - \frac{Y}{2}\right)}{F_y}} \text{ (LRFD)} \tag{3.3.15a}$$

$$t_{p(req)} = 2.58\sqrt{\frac{f_{p(max)}Y\left(m-\frac{Y}{2}\right)}{F_y}} \text{ (ASD)} \qquad (3.3.15b)$$

Note: When n is larger than m, the thickness will be governed by n. To determine the required thickness, substitute n for m in Equations 3.3.14 and 3.3.15.

3.4.3 Base Plate Yielding Limit at Tension Interface

The tension force T_u (LRFD), T_a (ASD) in the anchor rods will cause bending in the base plate. Cantilever action is conservatively assumed with the span length equal to the distance from the rod centerline to the center of the column flange, x. Alternately the bending lines could be assumed as shown in Figure 3.1.1. For a unit width of base plate, the required bending strength of the base plate can be determined as

$$M_{pl} = \frac{T_u x}{B} \text{ (LRFD)} \qquad (3.4.5a)$$

$$M_{pl} = \frac{T_a x}{B} \text{ (ASD)} \qquad (3.4.5b)$$

where

$$x = f - \frac{d}{2} + \frac{t_f}{2} \qquad (3.4.6)$$

with

d = depth of wide flange column section (see Fig. 3.1.1)

t_f = column flange thickness

The available strength per unit length for the plate is given in Equation 3.3.13. Setting that strength equal to the applied moment given by Equation 3.4.5 provides an expression for the required plate thickness:

$$t_{p(req)} = 2.11\sqrt{\frac{T_u x}{BF_y}} \text{ (LRFD)} \qquad (3.4.7a)$$

$$t_{p(req)} = 2.58\sqrt{\frac{T_a x}{BF_y}} \text{ (ASD)} \qquad (3.4.7b)$$

3.4.4 General Design Procedure

1. Determine the axial load and moment.

2. Pick a trial base plate size, $N \times B$.

3. Determine the equivalent eccentricity

$$e = M_r/P_r$$

and the critical eccentricity,

$$e_{crit} = \frac{N}{2} - \frac{P_r}{2q_{max}}$$

If $e > e_{crit}$, go to next step (design of the base plate with large moment); otherwise, refer to design of the base plate with *small* moment described in Section 3.3.

Check the inequality of Equation 3.4.4. If it is not satisfied, choose larger plate dimensions.

4. Determine the equivalent bearing length, Y and tensile force in the anchor rod, T_u (LRFD), T_a (ASD).

5. Determine the required minimum base plate thickness $t_{p(req)}$ at bearing and tension interfaces. Choose the larger value.

6. Determine the anchor rod size.

3.5 Design for Shear

There are three principal ways of transferring shear from column base plates into concrete:

1. Friction between the base plate and the grout or concrete surface.

2. Bearing of the column and base plate, and/or shear lug, against a concrete surface.

3. Shear in the anchor rods.

3.5.1 Friction

In typical base plate situations, the compression force between the base plate and the concrete will usually develop shear resistance sufficient to resist the lateral forces. The contribution of the shear should be based on the most unfavorable arrangement of factored compressive loads, P_u, that is consistent with the lateral force being evaluated, V_u. The shear strength can be calculated in accordance with ACI criteria,

$$\phi V_n = \phi\mu P_u \le 0.2 f_c' A_c$$

The friction coefficient μ is 0.55 for steel on grout, and 0.7 for steel on concrete.

3.5.2 Bearing

Shear forces can be transferred in bearing by the use of shear lugs or by embedding the column in the foundation. These methods are illustrated in Figure 3.5.1.

Anchor Bolt & Base Plate Design

Version #2

by: Luke Edwards 4/29/2021

Pin Connection: $P_u = 27.7\ k$ (~~9.7~~ column)

$$A_{1,req} = \frac{P_u}{\phi 0.85 f'_c} = \frac{27.7}{(0.65)(0.85)(4\ ksi)} = 12.5\ in^2$$

$$\Delta = \frac{0.95d - 0.8b_f}{2} = \frac{0.95(7) - 0.8(7)}{2} = 0.525$$

$N \approx \sqrt{A_{1,req}} + \Delta = \underset{\mathbb{Z}}{4.06} \rightarrow$ choose 13" based on spacing

$N = B = 13"$

$$m = \frac{N - 0.95d}{2} = \frac{13 - 0.95(7)}{2} = 3.175$$

$$n = \frac{B - 0.8b_f}{2} = \frac{13 - 0.8(7)}{2} = 3.7$$

$$\lambda = 1.0 \rightarrow \lambda n' = 1\frac{\sqrt{49}}{4} = 1.75$$

$\ell = \max(m, n, \lambda' n) = 3.7$ $\quad t_{min} = \ell\sqrt{\frac{2P_u}{\phi F_y BN}} = 3.7\sqrt{\frac{2(27.7)}{0.9(36)(13)^2}} = 0.372$

use 3/4" Anchor Rod by OSHA Requirement

3/4" dia rods ASTM F1554 Gr36 L = 9"

13" x 13" x 3/4" base plate A36

Moment: $P_u = 48k$ $M_u = 84$ k-ft

$N > d + 2(3in) = 8in + 2(3in) = 14in = B$

try $15in = N = B$

$f_{p,max} = \phi .85 f'_c = 0.65(0.85)(4ksi) = 2.21$ ksi

$q_{max} = f_{p,max}(B) = 2.21ksi \times 15in = 33.15$ k/in

$e = \frac{M_u}{P_u} = \frac{84}{48} = 1.75ft = 21in$

$e_{crit} = \frac{N}{2} - \frac{P_u}{2q_{max}} = \frac{15}{2} - \frac{48}{2(33.15)} = 6.78in$

$e > e_{crit}$ $f = \frac{N}{2} - 1.5in = 7.5 - 1.5 = 6in$

$\left(f + \frac{N}{2}\right)^2 = (6in + 7.5in)^2 = 182.25 in^2$

$\frac{2P_u(e+f)}{q_{max}} = \frac{2(48)(21+6)}{33.15} = 156 < 182$ ✓OKAY

$Y = \left(f + \frac{N}{2}\right) \pm \sqrt{\left(f + \frac{N}{2}\right)^2 - \frac{2P_u(e+f)}{q_{max}}} = (6+7.5) \pm \sqrt{(6+7.5)^2 - \frac{2(48)(21+6)}{33.15}}$

$= 3.3, 23.7$

$T_u = qY - P_u = 0$ $m = \frac{N - 0.95d}{2} = \frac{15in - 0.95(8in)}{2} = 3.7in$ $Y < m$

$t_{p,req} = 2.11\sqrt{\frac{2.21(3.3)(3.7 - \frac{3.3}{2})}{36}} = 1.36$

$\geq 2.11\sqrt{\frac{2.21(3.3)(4.3 - \frac{3.3}{2})}{36}} = \underline{1.55}$ controls

Use 1 5/8 in plate

3/4" dia rods ASTM F1554 Gr 36 L = 9"

15" x 15" x 1 5/8" base plate A36

Shallow Foundations:

f'_c : 4 ksi

Mark Designation:

Terminal All:	F72
Parking Cover All:	F102
Hangar Edge:	F114
Hangar Corner:	F78
Hangar Center:	F90

Schedule:

FOOTING SCHEDULE				
MARK	DEPTH	LENGTH	WIDTH	REINFORCEMENT
F72	1'-0"	6'-0"	6'-0"	(4)-#6 EW
F78	1'-6"	6'-6"	6'-6"	(5)-#6 EW
F90	1'-6"	7'-6"	7'-6"	(6)-#6 EW
F102	1'-6"	8'-6"	8'-6"	(7)-#6 EW
F114	1'-6"	9'-6"	9'-6"	(8)-#6 EW

Footing Sizing done in RISAFoundation; parking cover sizing checked by hand for conformance to model

Concrete Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (/1E..	Density[k/ft...	f'c[ksi]	Lambda	Flex Steel[...	Shear Stee...
1	Conc3000NW	3156	1372	.15	.6	.145	3	1	60	60
2	Conc3500NW	3409	1482	.15	.6	.145	3.5	1	60	60
3	Conc4000NW	3644	1584	.15	.6	.145	4	1	60	60
4	Conc3000LW	2085	907	.15	.6	.11	3	.75	60	60
5	Conc3500LW	2252	979	.15	.6	.11	3.5	.75	60	60
6	Conc4000LW	2408	1047	.15	.6	.11	4	.75	60	60

General Design Parameters

	Label	Max Bending Chk	Max Shear Chk	Top Cover[in]	Bottom Cover[in]
1	Typical	1	1	1.5	3

General Properties

	Label	Min Steel ...	Max Steel ...	Material	Design Ru...	Equal Bar Spacing	Group Design	Concrete Bearing	Force Top Bar
1	Footing 1	.002	.007	Conc4000...	Typical				

Footing Geometry

	Label	Max Length[..	Min Length[ft]	Max Width[ft]	Min Width[ft]	L/W Increm...	Max Thickn...	Min Thickne...	Thick Incre...	Force Sq...
1	Footing 1	10	2	10	2	.5	24	18	1	Yes

Pedestal Properties

	Label	Type	Shape	Height[in]	e/BL	ex[in]	ez[in]	BLx[ft]	BLz[ft]
1	Footing 1	Pedestal	CRECT12X12	24	Use ex,ez	0	0	0	0

Soil Properties

	Label	Overburden[ksf]	Passive[k]	Friction Coefficient	Gross/Net
1	Footing 1	.1	0	.3	Gross

Soil Definitions

	Label	Subgrade Modulus[k/ft^3]	Allowable Bearing[ksf]	Depth Properties	Default?
1	Default	100	3	None	Yes

Footing Geometry Results

	Joint	Footing	Length[ft]	Width[ft]	Thickness[in]	ex[in]	ez[in]	Pedestal Ht[in]	Ped Xdim[in]	Ped Zdim[in]
1	N1	Footing 1	8.5	8.5	18	0	0	24	12	12

Footing Steel

	Joint	Footing	Bot x Steel[in^2]	Bot z Steel[in^2]	Top x Steel[in...	Top z Steel[in...	Ped Long	Ped Shear
1	N1	Footing 1	3.534	3.534	0	0	12#6	#4@4 in

Footing Code Check

	Joint	Footing	Bearing Ra...	Bearing Pr...	Gov LC	UC Max	Muxx[k-ft]	Gov LC	UC Max	Muzz[k-ft]	Gov LC
1	N1	Footing 1	.867	2.6	1	.34	75.382	2	.346	76.659	2

Footing Shear Check

	Joint	Footing	UC Shear	Vux[k]	Gov LC	UC Shear	Vuz[k]	Gov LC
1	N1	Footing 1	.198	27.35	2	.202	27.81	2

Footing Pedestal Results

	Joint	Footing	UC Bend	UC Bend LC	UC Shear	UC Shear LC	UC Punch	UC Punch LC
1	N1	Footing 1	1.467	2	.106	2	.174	2

Footing Safety Factors

	Joint	Footing	OSF-xx	LC	OSF-zz	LC	SR-xx	LC	SR-zz	LC
1	N1	Footing 1	4.239	1	4.074	1	4.01	1	4.112	1

Material Takeoff

	Material	Quantity	Volume[yds^3]	Weight[K]
1	Footings			
2	Conc4000NW	1	4.1	16
3				
4	Totals			
5	Conc4000NW		4.1	16
6	Total Concrete		4.1	16

Concrete Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (/1E...	Density[k/ft...	f'c[ksi]	Lambda	Flex Steel[...	Shear Stee...
1	Conc3000NW	3156	1372	.15	.6	.145	3	1	60	60
2	Conc3500NW	3409	1482	.15	.6	.145	3.5	1	60	60
3	Conc4000NW	3644	1584	.15	.6	.145	4	1	60	60
4	Conc3000LW	2085	907	.15	.6	.11	3	.75	60	60
5	Conc3500LW	2252	979	.15	.6	.11	3.5	.75	60	60
6	Conc4000LW	2408	1047	.15	.6	.11	4	.75	60	60

General Design Parameters

	Label	Max Bending Chk	Max Shear Chk	Top Cover[in]	Bottom Cover[in]
1	Typical	1	1	1.5	3

General Properties

	Label	Min Steel ...	Max Steel ...	Material	Design Ru...	Equal Bar Spacing	Group Design	Concrete Bearing	Force Top Bar
1	Footing 1	.002	.007	Conc4000...	Typical				

Footing Geometry

	Label	Max Length[...	Min Length[ft]	Max Width[ft]	Min Width[ft]	L/W Increm...	Max Thickn...	Min Thickne...	Thick Incre...	Force Sq...
1	Footing 1	10	2	10	2	.5	24	12	1	Yes

Pedestal Properties

	Label	Type	Shape	Height[in]	e/BL	ex[in]	ez[in]	BLx[ft]	BLz[ft]
1	Footing 1	Pedestal	CRECT12X12	24	Use ex,ez	0	0	0	0

Soil Properties

	Label	Overburden[ksf]	Passive[k]	Friction Coefficient	Gross/Net
1	Footing 1	.1	0	.3	Gross

Soil Definitions

	Label	Subgrade Modulus[k/ft^3]	Allowable Bearing[ksf]	Depth Properties	Default?
1	Default	100	3	None	Yes

Footing Geometry Results

	Joint	Footing	Length[ft]	Width[ft]	Thickness[in]	ex[in]	ez[in]	Pedestal Ht[in]	Ped Xdim[in]	Ped Zdim[in]
1	N1	Footing 1	6	6	12	0	0	24	12	12
2	N2	Footing 1	4	4	12	0	0	24	12	12

Footing Steel

	Joint	Footing	Bot x Steel[in^2]	Bot z Steel[in^2]	Top x Steel[in...	Top z Steel[in...	Ped Long	Ped Shear
1	N1	Footing 1	2.209	2.209	0	0	8#6	#4@12 in
2	N2	Footing 1	1.767	1.767	0	0	4#6	#4@12 in

Footing Code Check

	Joint	Footing	Bearing Ra...	Bearing Pr...	Gov LC	UC Max	Muxx[k-ft]	Gov LC	UC Max	Muzz[k-ft]	Gov LC
1	N1	Footing 1	.999	2.998	1	.243	19.238	2	.271	21.501	2
2	N2	Footing 1	.78	2.341	1	.151	9.525	2	.171	10.745	2

Footing Shear Check

	Joint	Footing	UC Shear	Vux[k]	Gov LC	UC Shear	Vuz[k]	Gov LC
1	N1	Footing 1	.191	10.762	2	.212	11.97	2
2	N2	Footing 1	.183	6.884	2	.208	7.82	2

Footing Pedestal Results

	Joint	Footing	UC Bend	UC Bend LC	UC Shear	UC Shear LC	UC Punch	UC Punch LC
1	N1	Footing 1	.523	2	.126	2	.095	2
2	N2	Footing 1	.11	2	.055	2	.217	2

Footing Safety Factors

	Joint	Footing	OSF-xx	LC	OSF-zz	LC	SR-xx	LC	SR-zz	LC
1	N1	Footing 1	2.175	1	1.916	1	2.946	1	2.105	1
2	N2	Footing 1	238.524	1	18.301	1	8.235	1	107.336	1

Material Takeoff

	Material	Quantity	Volume[yds^3]	Weight[K]
1	Footings			
2	Conc4000NW	2	2.1	8.1
3				
4	Totals			
5	Conc4000NW		2.1	8.1
6	Total Concrete		2.1	8.1

Concrete Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (/1E..	Density[k/ft...	f'c[ksi]	Lambda	Flex Steel[...	Shear Stee...
1	Conc3000NW	3156	1372	.15	.6	.145	3	1	60	60
2	Conc3500NW	3409	1482	.15	.6	.145	3.5	1	60	60
3	Conc4000NW	3644	1584	.15	.6	.145	4	1	60	60
4	Conc3000LW	2085	907	.15	.6	.11	3	.75	60	60
5	Conc3500LW	2252	979	.15	.6	.11	3.5	.75	60	60
6	Conc4000LW	2408	1047	.15	.6	.11	4	.75	60	60

General Design Parameters

	Label	Max Bending Chk	Max Shear Chk	Top Cover[in]	Bottom Cover[in]
1	Typical	1	1	1.5	3

General Properties

	Label	Min Steel ...	Max Steel ...	Material	Design Ru...	Equal Bar Spacing	Group Design	Concrete Bearing	Force Top Bar
1	Footing 1	.002	.007	Conc4000...	Typical				

Footing Geometry

	Label	Max Length[..	Min Length[ft]	Max Width[ft]	Min Width[ft]	L/W Increm...	Max Thickn...	Min Thickne...	Thick Incre...	Force Sq...
1	Footing 1	10	2	10	2	.5	24	18	1	Yes

Pedestal Properties

	Label	Type	Shape	Height[in]	e/BL	ex[in]	ez[in]	BLx[ft]	BLz[ft]
1	Footing 1	Pedestal	CRECT18X18	24	Use ex,ez	0	0	0	0

Soil Properties

	Label	Overburden[ksf]	Passive[k]	Friction Coefficient	Gross/Net
1	Footing 1	.1	0	.3	Gross

Soil Definitions

	Label	Subgrade Modulus[k/ft^3]	Allowable Bearing[ksf]	Depth Properties	Default?
1	Default	100	3	None	Yes

Footing Geometry Results

	Joint	Footing	Length[ft]	Width[ft]	Thickness[in]	ex[in]	ez[in]	Pedestal Ht[in]	Ped Xdim[in]	Ped Zdim[in]
1	N3	Footing 1	5.5	5.5	18	0	0	24	18	18
2	N4	Footing 1	6.5	6.5	18	0	0	24	18	18
3	N9	Footing 1	5.5	5.5	18	0	0	24	18	18
4	N8	Footing 1	4.5	4.5	18	0	0	24	18	18
5	N5	Footing 1	7.5	7.5	18	0	0	24	18	18
6	N2	Footing 1	9.5	9.5	18	0	0	24	18	18
7	N1	Footing 1	6.5	6.5	18	0	0	24	18	18
8	N6	Footing 1	7.5	7.5	18	0	0	24	18	18
9	N7	Footing 1	9	9	18	0	0	24	18	18

Footing Steel

	Joint	Footing	Bot x Steel[in^2]	Bot z Steel[in^2]	Top x Steel[in...	Top z Steel[in...	Ped Long	Ped Shear
1	N3	Footing 1	2.209	2.209	0	0	4#6	#4@12 in
2	N4	Footing 1	2.651	2.651	0	0	4#6	#4@12 in
3	N9	Footing 1	2.209	2.209	0	0	4#6	#4@12 in

Footing Steel (Continued)

	Joint	Footing	Bot x Steel[in^2]	Bot z Steel[in^2]	Top x Steel[in...	Top z Steel[in...	Ped Long	Ped Shear
4	N8	Footing 1	1.767	1.767	0	0	4#6	#4@12 in
5	N5	Footing 1	3.093	3.093	0	0	4#6	#4@12 in
6	N2	Footing 1	3.976	3.976	0	0	8#6	#4@12 in
7	N1	Footing 1	2.651	2.651	0	0	4#6	#4@12 in
8	N6	Footing 1	3.093	3.093	0	0	4#6	#4@12 in
9	N7	Footing 1	3.534	3.534	0	0	12#6	#4@12 in

Footing Code Check

	Joint	Footing	Bearing Ra...	Bearing Pr...	Gov LC	UC Max	Muxx[k-ft]	Gov LC	UC Max	Muzz[k-ft]	Gov LC
1	N3	Footing 1	.925	2.774	1	.09	12.514	2	.121	16.785	2
2	N4	Footing 1	.912	2.737	1	.154	25.569	2	.243	40.356	2
3	N9	Footing 1	.967	2.901	1	.168	23.324	2	.125	17.291	2
4	N8	Footing 1	.841	2.522	1	.006	.693	2	.06	6.623	2
5	N5	Footing 1	.879	2.638	1	.009	1.655	2	.179	34.741	2
6	N2	Footing 1	.698	2.094	1	.211	52.518	2	.069	17.106	2
7	N1	Footing 1	.843	2.53	1	.121	20.186	2	.185	30.835	2
8	N6	Footing 1	.944	2.833	1	.184	35.675	2	.3	58.225	2
9	N7	Footing 1	.978	2.935	1	.19	42.204	2	.501	111.176	2

Footing Shear Check

	Joint	Footing	UC Shear	Vux[k]	Gov LC	UC Shear	Vuz[k]	Gov LC
1	N3	Footing 1	.06	5.359	2	.082	7.311	2
2	N4	Footing 1	.102	10.806	2	.166	17.472	2
3	N9	Footing 1	.111	9.88	2	.08	7.123	2
4	N8	Footing 1	.003	.203	2	.035	2.573	2
5	N5	Footing 1	.006	.675	2	.124	15.04	2
6	N2	Footing 1	.115	17.682	2	.038	5.859	2
7	N1	Footing 1	.082	8.668	2	.128	13.469	2
8	N6	Footing 1	.119	14.511	2	.197	23.909	2
9	N7	Footing 1	.105	15.347	2	.275	40.186	2

Footing Pedestal Results

	Joint	Footing	UC Bend	UC Bend LC	UC Shear	UC Shear LC	UC Punch	UC Punch LC
1	N3	Footing 1	.248	2	.046	2	.046	2
2	N4	Footing 1	.347	2	.065	2	.116	2
3	N9	Footing 1	.115	2	.056	2	.092	2
4	N8	Footing 1	.079	2	.02	2	.01	2
5	N5	Footing 1	.781	2	.078	2	.012	2
6	N2	Footing 1	.746	2	.163	2	.012	2
7	N1	Footing 1	.413	2	.093	2	.071	2
8	N6	Footing 1	.906	2	.17	2	.108	2
9	N7	Footing 1	.756	2	.237	2	.118	2

Footing Safety Factors

	Joint	Footing	OSF-xx	LC	OSF-zz	LC	SR-xx	LC	SR-zz	LC
1	N3	Footing 1	5.147	1	2.772	1	4.836	1	3.97	1
2	N4	Footing 1	30.527	1	3.923	1	5.745	1	61.857	1
3	N9	Footing 1	5.382	1	20.921	1	7.965	1	5.555	1
4	N8	Footing 1	26.064	1	1.304	1	2.562	1	68.423	1
5	N5	Footing 1	43.945	1	1.223	1	1.512	1	68.473	1

Footing Safety Factors (Continued)

	Joint	Footing	OSF-xx	LC	OSF-zz	LC	SR-xx	LC	SR-zz	LC
6	N2	Footing 1	1.471	1	3.866	1	3.516	1	1.136	1
7	N1	Footing 1	7.983	1	2.831	1	2.803	1	5.237	1
8	N6	Footing 1	8.44	1	2.552	1	2.168	1	6.425	1
9	N7	Footing 1	14.009	1	1.753	1	1.757	1	6.911	1

Material Takeoff

	Material	Quantity	Volume[yds^3]	Weight[K]
1	Footings			
2	Conc4000NW	9	26.4	103.5
3				
4	Totals			
5	Conc4000NW		26.4	103.5
6	Total Concrete		26.4	103.5

Footing Check | Performed by Luke Edwards 4/28/2021

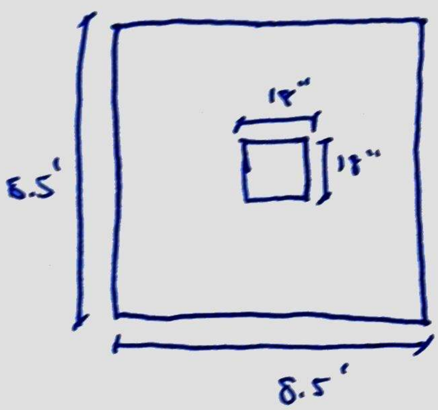
Footing Check is general parking cover footing

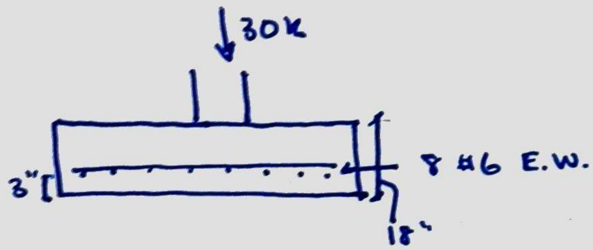
8.5' x 8.5' x 18" / Allowable Bearing 3ksf

Pedestal 18" x 18" / $f'_c = 4$ ksi

1' soil cover / $f_y = 60$ ksi

soil density 125 pcf



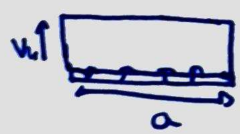


$$q_u = \frac{P_u}{A_f} = \frac{30k}{(8.5)^2} = 0.42\ k/ft^2$$

$$d = 18" - 3" = 15"$$

Wide Beam Action:

$$V_u = q \times \text{tributary area}$$



$$a = \frac{(8.5' - 18"/12)}{2} - \frac{15"}{12} = 2.25'$$

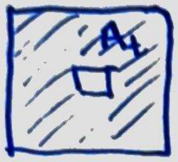
$$A_t = 8.5' \times 2.25' = 19.125\ ft^2$$

$$V_u = 19.125\ ft^2 \times 0.42\ k/ft^2 = 8.03\ k$$

$$\phi V_n = \phi(2\sqrt{f'_c}\,b_w d) = 0.75\,(2\sqrt{4000\ psi} \times 102" \times 15")/1000$$
$$= 145\ k$$

145 k > 8.03 k ✓ OKAY for one way shear

Two Way Shear:



$$A_t = 72.75 ft^2 - \left(\frac{18+15}{12}\right)^2 = 64.7 ft^2$$

$$V_u = 64.7 ft^2 (0.42 ksf) = 27.2 K$$

$$\frac{V_c}{\lambda \sqrt{f'_c}\, b_o d} = \min \begin{cases} 2 + \frac{4}{\beta} \\ \frac{\alpha_s d}{b_o} + 2 \\ 4 \end{cases}$$

$b_o = 4(18+15) = 132 \text{ in}$ $\quad \beta = 1 \quad \alpha_s = 40$

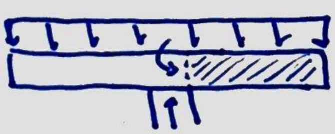
$$= \min \begin{cases} 2 + \frac{4}{1} = 6 \\ \frac{40(15)}{132} + 2 = 6.55 \\ 4 \longrightarrow \text{controls} \end{cases}$$

$$\phi V_c = 0.75(4)\sqrt{4000} \times 72.\cancel{25} \times 15/1000 = 205.6K$$

206 K > 27.2 K ✓ OKAY FOR TWO-WAY SHEAR

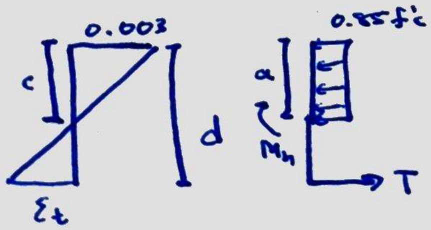
Flexure:

Critical Section is face of pedestal



$$M_u = \frac{w l^2}{2} = \frac{(0.42 ksf)(8.5')(3.5')^2}{2} = 21.9 k'$$

$A_s = 8 \#6 = 8(0.44 in^2) = 3.52 in^2$



$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(3.52)(60)}{0.85(4)(102)} = 0.61 \text{ in}$$

$$c = \frac{a}{\beta_1} = \frac{0.61}{0.85} = 0.72 \text{ in}$$

$f'_c \le 4$ ksi

$$\varepsilon_t = \frac{d-c}{d} 0.003 = \frac{15'' - 0.72 \text{ in}}{15''} 0.003 = 0.0029 > 0.002 \text{ ✓steel yields}$$

< 0.005 $\phi \ne 0.9$

$\phi = 0.57 + 67\varepsilon_t = 0.57 + 67(0.0029) = 0.76$

$M_n = T(d - a/2) = 3.52(60)(15" - \frac{0.61}{2}) = 3104 \text{ k in} = 259 \text{ k}'$

$M_n = 259 \text{ k}'$

$\phi M_n = 0.76(259\text{k}') = 197 \text{ k}' > 21.9 \text{ k}'$ ✓ OKAY FOR FLEXURE

FOOTING CHECKS STRUCTURALLY

Bearing on soil

max = 3 ksf   assume 100 psf surcharge

Net Allowable = $3 \text{ ksf} - 0.1 - 0.125(2.5') = 2.59 \text{ ksf}$

Required Area = $\frac{30\text{k}}{2.59 \text{ ksf}} = 11.58 \text{ ft}^2$

$(8.5 \text{ ft})^2 = 72.25 \text{ ft}^2 > 11.58 \text{ ft}^2$ ✓ OKAY

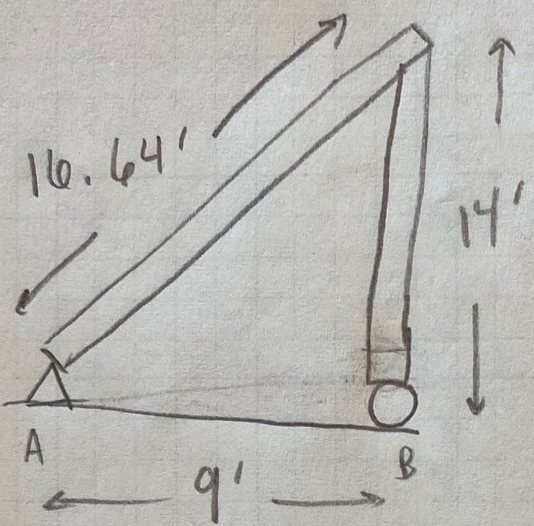
FOOTING CHECKS FOR BEARING

Blast Shield Foundation:

Type:	Mat Slab
f'_c :	4 ksi
Sizing:	17 ft deep 2 ft thick Length of Shield

Reactions found by hand calculations, sizing based on RISAFoundation

Blast Shield Calcs



Bar

$10.69 \text{ lbs/ft} (61.28 \text{ ft})$

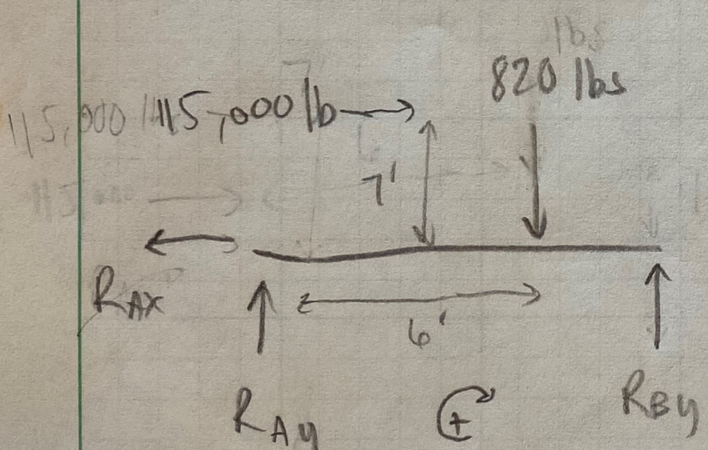
$= 655.0832 \text{ lbs}$

Sheet

$10 \text{ lb/ft}^2 (16.64 \text{ ft}^2)$

$= 166.4 \text{ lbs}$

$\boxed{\approx 820 \text{ lbs/ft of shield}}$



$\Sigma F_x = 115{,}000 \text{ lb} - R_{Ax} = 0$

$\boxed{R_{Ax} = 115{,}000 \text{ lb} \leftarrow}$

$\Sigma M_A = 115{,}000(7') + 820(6') - R_{By}(9') = 0$

$\boxed{R_{By} = 89{,}991 \text{ lbs} \uparrow}$

$\Sigma M_B = 115{,}000(7') - 820(3') + R_{Ay}(9) = 0$

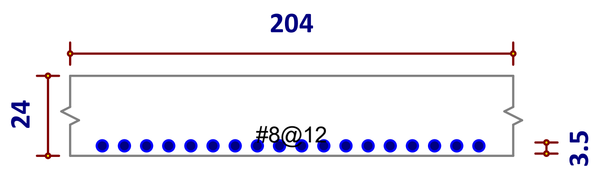
$\boxed{R_{Ay} = 8{,}398 \text{ lbs} \downarrow}$

Cut:	**DS1-X26**	Max Top bar Spac.:	**18 in**	Stress Block:	**Rectangular**
Material:	**Conc4000NW**	Min Top bar Spac.:	**3 in**		
Start:	**(15.1 , 10) ft**	Max Bot bar Spac.:	**18 in**	Rebar Spacing Inc:	**2 in**
End:	**(15.1 , 27) ft**	Min Bot bar Spac.:	**3 in**	Design Rule:	**Typical**

ACI 318-14 Code Check

Top Bending Check	**0.000**	Bot Bending Check	**0.088**	1 Way Shear Check	**0.103**
Gov Mu Top	**0 k-ft**	Gov Mu Bot	**-111.162 k-ft**	Gov Vu	**40.936 k**
phi*Mn Top	**0 k-ft**	phi*Mn Bot	**1265.254 k-ft**	phi*Vn	**396.739 k**
Governing LC	**N/A**	Governing LC	**2**	Governing LC	**2**
Tension Bar Fy	**60 ksi**	Concrete Weight	**.145 k/ft^3**	Top Cover	**1.5 in**
Shear Bar Fy	**60 ksi**	λ	**1**	Bottom Cover	**3 in**
F'c	**4 ksi**	E_Concrete	**3644 ksi**		
Flex. Rebar Set	**ASTM A615**				
Top As Reqd:		Bot As Reqd:			
Analysis	**NA**	Analysis	**1.208 in^2**		
4/3	**NA**	4/3	**NA**	As Reqd(T/S)	**8.81280**
Min Flex	**NA**	Min Flex	**8.813 in^2**	Rho Reqd(T/S)	**0.00180**
Top As Prvd	**NA**	Bot As Prvd	**14.137 in^2**	Rho Prvd(Gross)	**0.00289**

Cross Section Detailing(All Bars Equally Spaced, Units: in)



Appendix E: Construction Services and Calculations

Soil Cut/Fill Estimations:

Approximate Length of Slab:
440 feet

Approximate Width of Slab:
700 feet

Elevation of Bottom of Slope:
880 feet

Elevation of Top of Slope:
930 feet

Using Triangle Fill Calculations:

$$V = \frac{1}{2} * length * height * width$$

Slab:

$$V = \frac{1}{2} * 440' * 50' * 700'$$

314,815 yd^3

Hillside:

$$V = \frac{1}{2} * 30' * 80' * 700'$$

$30,222.22\ yd^3$

Total Cut/Fill Estimations:

$$V = 314,815\ yd^3 + 30,222.22\ yd^3$$

345,040 yd^3

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			STATE	$93,907.05	$187,814.10	2.00
203-01.11	PRESPLITTING OF ROCK EXCAVATION	S.Y.	2	$60.00	$30,000.00	500.00
			3	$19.50	$44,226.00	2268.00
			STATE	$26.82	$74,226.00	2768.00
203-01.60	ROAD & DRAINAGE EXCAVATION	C.Y.	2	$15.15	$342,874.80	22632.00
			STATE	$15.15	$342,874.80	22632.00
203-01.95	DESIGN-BUILD GRADING AND ROADWAYS	LS	3	$6,533,000.00	$6,533,000.00	1.00
			4	$1,683,758.89	$1,683,758.89	1.00
			STATE	$4,108,379.45	$8,216,758.89	2.00
203-02.01	BORROW EXCAVATION (GRADED SOLID ROCK)	TON	1	$33.86	$2,312,945.60	68311.00
			2	$28.43	$3,206,694.26	112793.41
			3	$16.93	$3,575,779.45	211164.00
			4	$35.26	$1,706,550.00	48405.00
			STATE	$24.51	$10,801,969.31	440673.41
203-03	BORROW EXCAVATION (UNCLASSIFIED)	C.Y.	1	$11.39	$249,253.00	21888.00
			2	$13.02	$2,299,523.73	176557.00
			3	$10.67	$2,858,837.17	268041.00
			4	$8.93	$461,055.00	51641.00
			STATE	$11.33	$5,868,668.90	518127.00
203-03.01	BORROW EXCAVATION (SELECT MATERIAL)	C.Y.	4	$25.54	$480,979.00	18830.00
			STATE	$25.54	$480,979.00	18830.00
203-03.10	SELECT GRANULAR MATERIAL	TON	2	$15.00	$130,920.00	8728.00
			4	$30.00	$4,500.00	150.00
			STATE	$15.25	$135,420.00	8878.00
203-03.15	BORROW EXCAVATION (CLAY)	C.Y.	3	$22.75	$39,243.75	1725.00
			STATE	$22.75	$39,243.75	1725.00
203-04	PLACING AND SPREADING TOPSOIL	C.Y.	1	$5.89	$304,246.50	51671.00
			2	$7.86	$64,942.10	8261.00
			3	$7.47	$723,244.14	96804.00
			4	$0.46	$42,283.30	91884.00
			STATE	$4.56	$1,134,716.04	248620.00
203-04.01	PLACING SPREADING SOIL FOR LANDSCAPING	C.Y.	2	$195.00	$8,190.00	42.00
			STATE	$195.00	$8,190.00	42.00
203-05	UNDERCUTTING	C.Y.	1	$11.52	$112,686.55	9778.00
			2	$26.46	$90,255.06	3411.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
209-03.43	STRM MITIG - VEGETATED RIP-RAP	C.Y.	3	$120.00	$107,400.00	895.00
			STATE	$120.00	$107,400.00	895.00
209-03.47	STRM MITIG - LONGTDNL STNE TOE	C.Y.	3	$300.00	$58,500.00	195.00
			STATE	$300.00	$58,500.00	195.00
209-03.67	STRM MTIGATION - WOOD TOE W/REINFO EARTH	L.F.	3	$150.00	$48,450.00	323.00
			STATE	$150.00	$48,450.00	323.00
209-05	SEDIMENT REMOVAL	C.Y.	1	$10.83	$57,118.89	5272.00
			2	$28.55	$76,364.90	2675.00
			3	$18.64	$200,037.72	10733.00
			4	$7.67	$52,837.64	6889.00
			STATE	$15.11	$386,359.15	25569.00
209-06.02	12" DIA COIR LOG (DESCRIPTION)	L.F.	2	$13.00	$2,600.00	200.00
			3	$11.16	$2,287.50	205.00
			STATE	$12.07	$4,887.50	405.00
209-08.01	TEMPORARY FILTER BARRIER	L.F.	4	$7.00	$2,800.00	400.00
			STATE	$7.00	$2,800.00	400.00
209-08.02	TEMPORARY SILT FENCE (WITH BACKING)	L.F.	1	$3.95	$175,739.28	44502.00
			2	$4.29	$120,094.41	27991.00
			3	$3.71	$833,003.56	224369.00
			4	$5.10	$199,121.80	39007.00
			STATE	$3.95	$1,327,959.05	335869.00
209-08.03	TEMPORARY SILT FENCE (WITHOUT BACKING)	L.F.	1	$1.78	$138,376.18	77684.00
			2	$1.81	$62,254.01	34408.00
			3	$1.75	$263,290.50	150069.00
			4	$2.90	$93,622.00	32265.00
			STATE	$1.89	$557,542.69	294426.00
209-08.05	ENHANCED SILT FENCE CHECK (V-DITCH)	EACH	3	$250.00	$750.00	3.00
			STATE	$250.00	$750.00	3.00
209-08.07	ROCK CHECK DAM	EACH	1	$239.91	$191,449.23	798.00
			2	$457.38	$83,700.58	183.00
			3	$281.17	$261,490.89	930.00
			4	$381.40	$207,101.03	543.00
			STATE	$303.07	$743,741.73	2454.00
209-08.08	ENHANCED ROCK CHECK DAM	EACH	1	$427.98	$101,860.33	238.00
			2	$745.44	$82,744.00	111.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			STATE	$15,000.00	$30,000.00	2.00
209-65.02	TEMPORARY STREAM DIVERSION	LS	2	$10,000.00	$10,000.00	1.00
			STATE	$10,000.00	$10,000.00	1.00
209-65.03	TEMPORARY DIVERSION CHANNEL	L.F.	1	$95.30	$13,818.50	145.00
			3	$40.44	$146,182.56	3615.00
			STATE	$42.55	$160,001.06	3760.00
209-65.04	TEMPORARY IN STREAM DIVERSION	L.F.	1	$69.11	$47,133.00	682.00
			2	$104.13	$67,997.00	653.00
			3	$57.28	$134,028.24	2340.00
			4	$50.00	$10,000.00	200.00
			STATE	$66.88	$259,158.24	3875.00
209-70.01	VACUUM TRUCK/SWEEPER FOR ROADWAY DEBRIS	HOUR	2	$190.00	$15,200.00	80.00
			STATE	$190.00	$15,200.00	80.00
301-50.50	DESIGN-BUILD PAVEMENT	LS	3	$8,499,999.99	$8,499,999.99	1.00
			4	$1,302,514.98	$1,302,514.98	1.00
			STATE	$4,901,257.49	$9,802,514.97	2.00
303-01	MINERAL AGGREGATE, TY A BASE, GRADING D	TON	1	$23.05	$7,013,101.23	304214.75
			2	$29.93	$3,915,942.67	130852.12
			3	$19.61	$11,851,543.76	604257.00
			4	$30.17	$1,546,096.20	51248.00
			STATE	$22.31	$24,326,683.86	1090571.87
303-01.01	GRANULAR BACKFILL (ROADWAY)	TON	1	$30.42	$227,651.72	7484.00
			2	$46.50	$42,548.75	915.00
			3	$16.73	$576,987.65	34483.00
			4	$26.00	$59,930.00	2305.00
			STATE	$20.07	$907,118.12	45187.00
303-01.02	GRANULAR BACKFILL (BRIDGES)	TON	1	$54.32	$30,416.73	560.00
			2	$38.68	$182,538.60	4719.00
			3	$47.82	$49,585.78	1037.00
			4	$61.70	$580,652.08	9411.00
			STATE	$53.61	$843,193.19	15727.00
303-01.03	GRANULAR BACKFILL (RETAINING WALLS)	TON	1	$40.00	$6,320.00	158.00
			STATE	$40.00	$6,320.00	158.00
303-01.09	MINERAL AGGR,TY A BS,GRADING D LIMESTONE	TON	4	$30.00	$9,711,360.00	323712.00
			STATE	$30.00	$9,711,360.00	323712.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
303-02	MINERAL AGGR,TY B BASE, GR	TON	3	$17.85	$75,094.95	4207.00
			4	$30.68	$1,310,133.00	42701.00
			STATE	$29.53	$1,385,227.95	46908.00
303-10.01	MINERAL AGGREGATE (SIZE 57)	TON	1	$28.75	$87,210.14	3033.00
			2	$38.00	$74,935.56	1972.20
			3	$34.24	$301,655.01	8810.00
			4	$43.86	$438,721.91	10002.00
			STATE	$37.89	$902,522.62	23817.20
303-10.03	MINERAL AGGREGATE (SIZE 68)	TON	3	$30.85	$34,490.30	1118.00
			STATE	$30.85	$34,490.30	1118.00
303-10.04	MINERAL AGGREGATE	TON	3	$66.98	$1,406.58	21.00
			STATE	$66.98	$1,406.58	21.00
303-10.06	MINERAL AGGREGATE	TON	2	$52.00	$2,548.00	49.00
			STATE	$52.00	$2,548.00	49.00
303-20.02	RIVER GRAVEL	TON	3	$100.00	$76,300.00	763.00
			STATE	$100.00	$76,300.00	763.00
304-01.04	PROCESSING (RECLAIMED BASE MATERIAL)	S.Y.	4	$2.99	$382,669.17	127983.00
			STATE	$2.99	$382,669.17	127983.00
304-01.08	PORTLAND CEMENT (FULL DEPTH RECLAMATION)	TON	4	$167.00	$790,912.00	4736.00
			STATE	$167.00	$790,912.00	4736.00
307-01.01	ASP. CONC. MIX(PG64-22) (BPMB-HM) GR. A	TON	1	$84.74	$806,049.01	9512.00
			2	$130.84	$418,214.10	3196.30
			3	$83.48	$1,664,566.62	19939.00
			4	$136.76	$1,172,291.85	8571.76
			STATE	$98.53	$4,061,121.58	41219.06
307-01.07	ASPHALT CONC MIX(PG64-22)(BPMB-HM)GR B-M	TON	3	$72.00	$72,000.00	1000.00
			STATE	$72.00	$72,000.00	1000.00
307-01.08	ASPHALT CONC MX(PG64-22)(BPMB-HM)GR B-M2	TON	1	$100.30	$1,042,665.59	10395.67
			2	$104.66	$1,236,010.66	11810.20
			3	$86.81	$2,857,884.77	32922.40
			4	$129.22	$971,882.82	7521.25
			STATE	$97.50	$6,108,443.84	62649.52
307-01.09	ASPHALT CONC MIX (PG64-22)(BPMB-HM)GR C	TON	2	$97.00	$69,646.00	718.00
			STATE	$97.00	$69,646.00	718.00
307-01.10	ASPHALT CONC MIX(PG64-22)(BPMB-HM)GR C-W	TON	2	$93.50	$663,476.00	7096.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
502-08.10	SAWING & RESEAL JOINTS (SILICONE SLNT)	L.F.	4	$2.00	$521,304.00	260652.00
			STATE	$2.00	$521,304.00	260652.00
502-10	CEMENT-FLY ASH GROUT	C.F.	1	$0.75	$75.00	100.00
			2	$0.75	$75.00	100.00
			3	$0.75	$60.00	80.00
			STATE	$0.75	$210.00	280.00
502-25	SAWING CONCRETE JOINTS	L.F.	1	$1.50	$3,000.00	2000.00
			2	$2.20	$3,300.00	1500.00
			3	$3.00	$4,500.00	1500.00
			4	$3.00	$6,000.00	2000.00
			STATE	$2.40	$16,800.00	7000.00
503-01	GRINDING CONCRETE PAVEMENT	S.Y.	1	$12.00	$12,000.00	1000.00
			2	$12.00	$18,000.00	1500.00
			3	$9.00	$6,750.00	750.00
			4	$7.22	$305,900.31	42379.00
			STATE	$7.51	$342,650.31	45629.00
503-01.01	MILLING CONCRETE PAVEMENT	S.Y.	4	$38.17	$40,425.00	1059.00
			STATE	$38.17	$40,425.00	1059.00
503-60	RETROFIT DOWEL BAR	EACH	1	$14.75	$1,475.00	100.00
			2	$15.00	$750.00	50.00
			3	$40.00	$4,000.00	100.00
			4	$60.00	$1,500.00	25.00
			STATE	$28.09	$7,725.00	275.00
602-01	STRUCTURAL STEEL	LB.	4	$5.00	$38,110.00	7622.00
			STATE	$5.00	$38,110.00	7622.00
602-02.01	STRUCTURAL STL	LB.	2	$0.65	$494,650.00	761000.00
			3	$9.00	$12,150.00	1350.00
			STATE	$0.66	$506,800.00	762350.00
602-02.02	STRUCTURAL STL	LB.	2	$3.30	$342,441.00	103770.00
			STATE	$3.30	$342,441.00	103770.00
602-02.10	STRUCTURAL STL	LS	2	$150,000.00	$150,000.00	1.00
			STATE	$150,000.00	$150,000.00	1.00
602-02.11	STRUCTURAL STEEL (W/SUPP. DESCRIPTION)	LS	2	$150,000.00	$150,000.00	1.00
			STATE	$150,000.00	$150,000.00	1.00
602-03.02	PEDESTRIAN BRIDGE	LS	1	$387,000.00	$387,000.00	1.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			STATE	$387,000.00	$387,000.00	1.00
602-04.01	STL STRUCTURES	LS	4	$1,700,000.00	$1,700,000.00	1.00
			STATE	$1,700,000.00	$1,700,000.00	1.00
602-04.02	STL STRUCTURES	LS	4	$750,000.00	$750,000.00	1.00
			STATE	$750,000.00	$750,000.00	1.00
602-04.03	STL STRUCTURES	LS	4	$750,000.00	$750,000.00	1.00
			STATE	$750,000.00	$750,000.00	1.00
602-08.01	JACKING STRUCTURES	LS	2	$58,180.99	$58,180.99	1.00
			3	$44,300.00	$44,300.00	1.00
			STATE	$51,240.50	$102,480.99	2.00
602-10.01	STRUCTURAL STEEL REPAIRS	LS	2	$10,009.70	$20,019.39	2.00
			STATE	$10,009.70	$20,019.39	2.00
602-10.05	BRACING REPAIRS	LS	2	$14,546.98	$14,546.98	1.00
			4	$11,464.51	$11,464.51	1.00
			STATE	$13,005.75	$26,011.49	2.00
602-10.10	ANCHOR BOLTS	EACH	1	$1,840.00	$29,440.00	16.00
			STATE	$1,840.00	$29,440.00	16.00
602-10.19	JACKING STEEL SPANS	LS	1	$70,000.00	$140,000.00	2.00
			STATE	$70,000.00	$140,000.00	2.00
602-10.20	BOLTS	EACH	2	$271.76	$5,163.52	19.00
			STATE	$271.76	$5,163.52	19.00
602-10.32	STRUCTURAL STEEL (REPAIRS)	LB.	3	$10.48	$86,040.00	8208.00
			STATE	$10.48	$86,040.00	8208.00
602-10.50	STRUCTURAL STEEL REPAIR	EACH	4	$943.18	$41,500.00	44.00
			STATE	$943.18	$41,500.00	44.00
602-10.51	STRUCTURAL STEEL REPAIR(DESCRIPTION)	EACH	1	$8,000.00	$8,000.00	1.00
			STATE	$8,000.00	$8,000.00	1.00
602-10.52	STRUCTURAL STEEL REPAIR(DESCRIPTION)	EACH	1	$8,000.00	$8,000.00	1.00
			STATE	$8,000.00	$8,000.00	1.00
602-10.53	STRUCTURAL STEEL REPAIR(DESCRIPTION)	EACH	1	$400.00	$45,600.00	114.00
			STATE	$400.00	$45,600.00	114.00
602-10.54	STRUCTURAL STEEL REPAIR(DESCRIPTION)	EACH	1	$7,500.00	$555,000.00	74.00
			STATE	$7,500.00	$555,000.00	74.00
602-10.55	STRUCTURAL STEEL REPAIR(DESCRIPTION)	EACH	1	$1,000.00	$16,000.00	16.00
			STATE	$1,000.00	$16,000.00	16.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			STATE	$93,907.05	$187,814.10	2.00
203-01.11	PRESPLITTING OF ROCK EXCAVATION	S.Y.	2	$60.00	$30,000.00	500.00
			3	$19.50	$44,226.00	2268.00
			STATE	$26.82	$74,226.00	2768.00
203-01.60	ROAD & DRAINAGE EXCAVATION	C.Y.	2	$15.15	$342,874.80	22632.00
			STATE	$15.15	$342,874.80	22632.00
203-01.95	DESIGN-BUILD GRADING AND ROADWAYS	LS	3	$6,533,000.00	$6,533,000.00	1.00
			4	$1,683,758.89	$1,683,758.89	1.00
			STATE	$4,108,379.45	$8,216,758.89	2.00
203-02.01	BORROW EXCAVATION (GRADED SOLID ROCK)	TON	1	$33.86	$2,312,945.60	68311.00
			2	$28.43	$3,206,694.26	112793.41
			3	$16.93	$3,575,779.45	211164.00
			4	$35.26	$1,706,550.00	48405.00
			STATE	$24.51	$10,801,969.31	440673.41
203-03	BORROW EXCAVATION (UNCLASSIFIED)	C.Y.	1	$11.39	$249,253.00	21888.00
			2	$13.02	$2,299,523.73	176557.00
			3	$10.67	$2,858,837.17	268041.00
			4	$8.93	$461,055.00	51641.00
			STATE	$11.33	$5,868,668.90	518127.00
203-03.01	BORROW EXCAVATION (SELECT MATERIAL)	C.Y.	4	$25.54	$480,979.00	18830.00
			STATE	$25.54	$480,979.00	18830.00
203-03.10	SELECT GRANULAR MATERIAL	TON	2	$15.00	$130,920.00	8728.00
			4	$30.00	$4,500.00	150.00
			STATE	$15.25	$135,420.00	8878.00
203-03.15	BORROW EXCAVATION (CLAY)	C.Y.	3	$22.75	$39,243.75	1725.00
			STATE	$22.75	$39,243.75	1725.00
203-04	PLACING AND SPREADING TOPSOIL	C.Y.	1	$5.89	$304,246.50	51671.00
			2	$7.86	$64,942.10	8261.00
			3	$7.47	$723,244.14	96804.00
			4	$0.46	$42,283.30	91884.00
			STATE	$4.56	$1,134,716.04	248620.00
203-04.01	PLACING SPREADING SOIL FOR LANDSCAPING	C.Y.	2	$195.00	$8,190.00	42.00
			STATE	$195.00	$8,190.00	42.00
203-05	UNDERCUTTING	C.Y.	1	$11.52	$112,686.55	9778.00
			2	$26.46	$90,255.06	3411.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			STATE	$93,907.05	$187,814.10	2.00
203-01.11	PRESPLITTING OF ROCK EXCAVATION	S.Y.	2	$60.00	$30,000.00	500.00
			3	$19.50	$44,226.00	2268.00
			STATE	$26.82	$74,226.00	2768.00
203-01.60	ROAD & DRAINAGE EXCAVATION	C.Y.	2	$15.15	$342,874.80	22632.00
			STATE	$15.15	$342,874.80	22632.00
203-01.95	DESIGN-BUILD GRADING AND ROADWAYS	LS	3	$6,533,000.00	$6,533,000.00	1.00
			4	$1,683,758.89	$1,683,758.89	1.00
			STATE	$4,108,379.45	$8,216,758.89	2.00
203-02.01	BORROW EXCAVATION (GRADED SOLID ROCK)	TON	1	$33.86	$2,312,945.60	68311.00
			2	$28.43	$3,206,694.26	112793.41
			3	$16.93	$3,575,779.45	211164.00
			4	$35.26	$1,706,550.00	48405.00
			STATE	$24.51	$10,801,969.31	440673.41
203-03	BORROW EXCAVATION (UNCLASSIFIED)	C.Y.	1	$11.39	$249,253.00	21888.00
			2	$13.02	$2,299,523.73	176557.00
			3	$10.67	$2,858,837.17	268041.00
			4	$8.93	$461,055.00	51641.00
			STATE	$11.33	$5,868,668.90	518127.00
203-03.01	BORROW EXCAVATION (SELECT MATERIAL)	C.Y.	4	$25.54	$480,979.00	18830.00
			STATE	$25.54	$480,979.00	18830.00
203-03.10	SELECT GRANULAR MATERIAL	TON	2	$15.00	$130,920.00	8728.00
			4	$30.00	$4,500.00	150.00
			STATE	$15.25	$135,420.00	8878.00
203-03.15	BORROW EXCAVATION (CLAY)	C.Y.	3	$22.75	$39,243.75	1725.00
			STATE	$22.75	$39,243.75	1725.00
203-04	PLACING AND SPREADING TOPSOIL	C.Y.	1	$5.89	$304,246.50	51671.00
			2	$7.86	$64,942.10	8261.00
			3	$7.47	$723,244.14	96804.00
			4	$0.46	$42,283.30	91884.00
			STATE	$4.56	$1,134,716.04	248620.00
203-04.01	PLACING SPREADING SOIL FOR LANDSCAPING	C.Y.	2	$195.00	$8,190.00	42.00
			STATE	$195.00	$8,190.00	42.00
203-05	UNDERCUTTING	C.Y.	1	$11.52	$112,686.55	9778.00
			2	$26.46	$90,255.06	3411.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			STATE	$93,907.05	$187,814.10	2.00
203-01.11	PRESPLITTING OF ROCK EXCAVATION	S.Y.	2	$60.00	$30,000.00	500.00
			3	$19.50	$44,226.00	2268.00
			STATE	$26.82	$74,226.00	2768.00
203-01.60	ROAD & DRAINAGE EXCAVATION	C.Y.	2	$15.15	$342,874.80	22632.00
			STATE	$15.15	$342,874.80	22632.00
203-01.95	DESIGN-BUILD GRADING AND ROADWAYS	LS	3	$6,533,000.00	$6,533,000.00	1.00
			4	$1,683,758.89	$1,683,758.89	1.00
			STATE	$4,108,379.45	$8,216,758.89	2.00
203-02.01	BORROW EXCAVATION (GRADED SOLID ROCK)	TON	1	$33.86	$2,312,945.60	68311.00
			2	$28.43	$3,206,694.26	112793.41
			3	$16.93	$3,575,779.45	211164.00
			4	$35.26	$1,706,550.00	48405.00
			STATE	$24.51	$10,801,969.31	440673.41
203-03	BORROW EXCAVATION (UNCLASSIFIED)	C.Y.	1	$11.39	$249,253.00	21888.00
			2	$13.02	$2,299,523.73	176557.00
			3	$10.67	$2,858,837.17	268041.00
			4	$8.93	$461,055.00	51641.00
			STATE	$11.33	$5,868,668.90	518127.00
203-03.01	BORROW EXCAVATION (SELECT MATERIAL)	C.Y.	4	$25.54	$480,979.00	18830.00
			STATE	$25.54	$480,979.00	18830.00
203-03.10	SELECT GRANULAR MATERIAL	TON	2	$15.00	$130,920.00	8728.00
			4	$30.00	$4,500.00	150.00
			STATE	$15.25	$135,420.00	8878.00
203-03.15	BORROW EXCAVATION (CLAY)	C.Y.	3	$22.75	$39,243.75	1725.00
			STATE	$22.75	$39,243.75	1725.00
203-04	PLACING AND SPREADING TOPSOIL	C.Y.	1	$5.89	$304,246.50	51671.00
			2	$7.86	$64,942.10	8261.00
			3	$7.47	$723,244.14	96804.00
			4	$0.46	$42,283.30	91884.00
			STATE	$4.56	$1,134,716.04	248620.00
203-04.01	PLACING SPREADING SOIL FOR LANDSCAPING	C.Y.	2	$195.00	$8,190.00	42.00
			STATE	$195.00	$8,190.00	42.00
203-05	UNDERCUTTING	C.Y.	1	$11.52	$112,686.55	9778.00
			2	$26.46	$90,255.06	3411.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			STATE	$1.06	$1,847,629.86	1747050.00
604-03.04	PAVEMENT @ BRIDGE ENDS	S.Y.	1	$252.29	$351,187.20	1392.00
			2	$356.46	$581,382.88	1631.00
			3	$305.67	$1,195,474.29	3911.00
			4	$464.96	$1,545,977.12	3325.00
			STATE	$358.13	$3,674,021.49	10259.00
604-03.07	CLASS A CONCRETE	C.Y.	1	$800.00	$76,800.00	96.00
			2	$2,622.83	$18,359.81	7.00
			3	$750.00	$6,750.00	9.00
			STATE	$909.91	$101,909.81	112.00
604-03.08	CLASS A CONCRETE	C.Y.	2	$300.00	$341,700.00	1139.00
			STATE	$300.00	$341,700.00	1139.00
604-03.09	CLASS D CONCRETE (BRIDGE DECK)	C.Y.	1	$1,248.45	$322,100.10	258.00
			2	$823.43	$496,527.40	603.00
			3	$813.30	$239,110.20	294.00
			4	$784.74	$902,451.27	1150.00
			STATE	$850.41	$1,960,188.97	2305.00
604-03.20	BRIDGE JOINT MODIFICATION	L.F.	2	$266.05	$34,586.80	130.00
			STATE	$266.05	$34,586.80	130.00
604-03.32	CLASS DS CONCRETE	C.Y.	1	$700.18	$1,435,369.00	2050.00
			2	$950.00	$434,150.00	457.00
			3	$743.21	$2,341,121.78	3150.00
			4	$629.38	$1,380,236.40	2193.00
			STATE	$712.21	$5,590,877.18	7850.00
604-03.60	BR JOINT SEISMIC MOD	EACH	4	$1,269.61	$97,760.00	77.00
			STATE	$1,269.61	$97,760.00	77.00
604-03.74	CLASS X CONCRETE	C.Y.	2	$1,921.45	$38,429.00	20.00
			4	$1,518.74	$485,995.52	320.00
			STATE	$1,542.43	$524,424.52	340.00
604-04.01	APPLIED TEXTURE FINISH (NEW STRUCTURES)	S.Y.	1	$7.05	$112,980.02	16030.00
			2	$7.44	$60,821.98	8175.00
			3	$7.80	$88,446.17	11340.00
			4	$8.46	$104,621.92	12366.00
			STATE	$7.66	$366,870.09	47911.00
604-04.02	APPLIED TEXTURE FINISH (EX STRUCTURES)	S.Y.	1	$14.37	$197,418.60	13740.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			STATE	$1,716.21	$353,540.00	206.00
607-11.03	60" CONCRETE PIPE CULVERT (CLASS III)	L.F.	1	$264.27	$109,143.51	413.00
			3	$290.00	$46,980.00	162.00
			STATE	$271.52	$156,123.51	575.00
607-13.03	72" CONCRETE PIPE CULVERT (CLASS III)	L.F.	3	$430.00	$63,210.00	147.00
			STATE	$430.00	$63,210.00	147.00
607-13.30	72" PIPE CULVERT	L.F.	1	$475.12	$5,226.32	11.00
			STATE	$475.12	$5,226.32	11.00
607-16.02	30"X 19"HORIZONTAL OVAL CNC PIPE CULVERT	L.F.	3	$110.00	$5,500.00	50.00
			STATE	$110.00	$5,500.00	50.00
607-16.09	60"X 38"HORIZONTAL OVAL CNC PIPE CULVERT	L.F.	1	$625.00	$13,750.00	22.00
			STATE	$625.00	$13,750.00	22.00
607-20.01	18" CROSSDRN P CLV(COLLECTORS&LOC ROADS)	L.F.	1	$60.00	$20,700.00	345.00
			STATE	$60.00	$20,700.00	345.00
607-20.02	24" CROSSDRN P CLV(COLLECTORS&LOC ROADS)	L.F.	1	$90.00	$4,860.00	54.00
			STATE	$90.00	$4,860.00	54.00
607-20.04	36" CROSSDRN P CLV(COLLECTORS&LOC ROADS)	L.F.	1	$125.00	$7,750.00	62.00
			STATE	$125.00	$7,750.00	62.00
607-25.01	SAPL TYPE 1 GROUT (REPAIR)	C.F.	4	$101.98	$53,032.00	520.00
			STATE	$101.98	$53,032.00	520.00
607-25.02	SPRAY APPLIED PIPE LINER (SAPL)	C.F.	4	$231.23	$514,024.00	2223.00
			STATE	$231.23	$514,024.00	2223.00
607-37.01	15" CORRUGATED METAL PIPE CULVERT	L.F.	1	$85.93	$1,546.80	18.00
			3	$63.50	$1,905.00	30.00
			STATE	$71.91	$3,451.80	48.00
607-37.02	18" CORRUGATED METAL PIPE CULVERT	L.F.	1	$78.00	$6,396.00	82.00
			2	$95.73	$5,743.80	60.00
			3	$65.85	$658.50	10.00
			STATE	$84.20	$12,798.30	152.00
607-37.03	24" CORRUGATED METAL PIPE CULVERT	L.F.	1	$80.00	$1,920.00	24.00
			2	$108.44	$2,819.44	26.00
			3	$108.70	$9,457.00	87.00
			STATE	$103.62	$14,196.44	137.00
607-37.04	30" CORRUGATED METAL PIPE CULVERT	L.F.	1	$120.00	$3,360.00	28.00
			STATE	$120.00	$3,360.00	28.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
706-80.19	CABLE BARRIER (REMOVAL)	L.F.	4	$2.50	$73,950.00	29580.00
			STATE	$2.50	$73,950.00	29580.00
707-01.01	CHAIN-LINK FENCE (4-FOOT)	L.F.	2	$20.58	$1,975.68	96.00
			STATE	$20.58	$1,975.68	96.00
707-01.02	END & CORNER POST ASSEMBLY(CL FENCE 4')	EACH	2	$270.78	$812.34	3.00
			STATE	$270.78	$812.34	3.00
707-01.11	CHAIN LINK FENCE (6 FOOT)	L.F.	2	$11.99	$70,873.05	5913.00
			3	$13.12	$17,278.30	1317.00
			4	$11.32	$205,644.70	18170.00
			STATE	$11.57	$293,796.05	25400.00
707-01.12	END & CORNER POST ASM(CL FENCE 6')	EACH	2	$265.00	$11,660.00	44.00
			3	$307.82	$5,233.02	17.00
			4	$248.50	$20,874.00	84.00
			STATE	$260.46	$37,767.02	145.00
707-01.13	GATE - CL FENCE-6 FOOT	EACH	2	$1,160.00	$2,320.00	2.00
			STATE	$1,160.00	$2,320.00	2.00
707-01.14	GATE - CL FENCE-6 FOOT	EACH	2	$1,690.00	$6,760.00	4.00
			STATE	$1,690.00	$6,760.00	4.00
707-02.43	ROCK ANCHOR, TYPE I	L.F.	3	$80.74	$245,449.60	3040.00
			STATE	$80.74	$245,449.60	3040.00
707-02.44	ROCK ANCHOR, TYPE II	L.F.	1	$87.18	$195,283.20	2240.00
			STATE	$87.18	$195,283.20	2240.00
707-03.01	STOCK FENCE	L.F.	3	$8.51	$8,186.40	962.00
			4	$5.50	$267,960.00	48720.00
			STATE	$5.56	$276,146.40	49682.00
707-03.02	END,BRACED LINE,CORNER POST ASM (S.F.)	EACH	3	$198.05	$9,308.48	47.00
			4	$150.00	$32,250.00	215.00
			STATE	$158.62	$41,558.48	262.00
707-03.20	DRIVE GATE (STOCK FENCE) (DESCRIPTION)	EACH	4	$1,200.00	$3,600.00	3.00
			STATE	$1,200.00	$3,600.00	3.00
707-03.21	WALK GATE (STOCK FENCE) (DESCRIPTION)	EACH	4	$400.00	$1,200.00	3.00
			STATE	$400.00	$1,200.00	3.00
707-06.01	REMOVAL OF FENCE	L.F.	2	$4.25	$30,986.75	7291.00
			3	$3.35	$4,030.88	1204.00
			4	$2.31	$153,530.00	66527.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			STATE	$2.51	$188,547.63	75022.00
707-06.02	REMOVAL OF GATE	EACH	2	$79.25	$475.50	6.00
			STATE	$79.25	$475.50	6.00
707-06.04	REMOVAL AND RESET GATE	EACH	2	$1,133.00	$1,133.00	1.00
			3	$257.07	$257.07	1.00
			STATE	$695.04	$1,390.07	2.00
707-06.05	REMOVAL OF FENCE	LS	2	$2,678.00	$2,678.00	1.00
			STATE	$2,678.00	$2,678.00	1.00
707-07.01	CHAIN-LINK FENCE (BRIDGES)	S.F.	1	$23.45	$27,483.40	1172.00
			2	$19.75	$69,596.75	3524.00
			3	$20.09	$60,973.15	3035.00
			4	$24.49	$44,449.35	1815.00
			STATE	$21.21	$202,502.65	9546.00
707-08.01	FENCE	L.F.	1	$309.75	$589,764.00	1904.00
			2	$90.64	$34,443.20	380.00
			STATE	$273.30	$624,207.20	2284.00
707-08.11	HIGH-VISIBILITY CONSTRUCTION FENCE	L.F.	1	$2.06	$12,484.05	6057.00
			2	$1.93	$18,916.50	9815.00
			3	$1.80	$63,722.55	35431.00
			4	$2.92	$73,002.30	25031.00
			STATE	$2.20	$168,125.40	76334.00
707-10.06	ROCKFALL DRAPE (TYPE II)	S.Y.	1	$157.18	$60,514.30	385.00
			STATE	$157.18	$60,514.30	385.00
707-10.07	ROCKFALL DRAPE (TYPE III)	S.Y.	3	$60.45	$1,158,403.35	19163.00
			STATE	$60.45	$1,158,403.35	19163.00
707-11.01	PEDESTRIAN CONSTRUCTION BARRIER FENCE	L.F.	1	$20.50	$5,740.00	280.00
			2	$21.75	$7,503.75	345.00
			3	$21.92	$24,395.00	1113.00
			STATE	$21.66	$37,638.75	1738.00
708-01.01	MONUMENTS	EACH	3	$200.00	$15,200.00	76.00
			STATE	$200.00	$15,200.00	76.00
708-02.01	MARKERS (CONCRETE R.O.W. POSTS)	EACH	1	$266.01	$20,482.72	77.00
			2	$293.30	$38,422.82	131.00
			3	$284.98	$201,482.45	707.00
			4	$195.52	$17,010.00	87.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			3	$4.07	$51,945.96	12751.35
			4	$3.80	$194,852.50	51234.00
			STATE	$4.01	$368,431.26	91986.35
713-09.01	STEEL OVERHEAD SIGN STRUCTURE	EACH	1	$81,007.50	$81,007.50	1.00
			2	$56,500.00	$56,500.00	1.00
			3	$51,084.00	$102,168.00	2.00
			4	$75,000.00	$75,000.00	1.00
			STATE	$62,935.10	$314,675.50	5.00
713-09.02	STEEL OVERHEAD SIGN STRUCTURE	EACH	1	$59,745.00	$59,745.00	1.00
			2	$77,600.00	$77,600.00	1.00
			STATE	$68,672.50	$137,345.00	2.00
713-09.03	STEEL OVERHEAD SIGN STRUCTURE	EACH	2	$65,500.00	$65,500.00	1.00
			STATE	$65,500.00	$65,500.00	1.00
713-09.04	STEEL OVERHEAD SIGN STRUCTURE	EACH	2	$66,300.00	$66,300.00	1.00
			STATE	$66,300.00	$66,300.00	1.00
713-09.05	STEEL OVERHEAD SIGN STRUCTURE	EACH	2	$65,100.00	$65,100.00	1.00
			STATE	$65,100.00	$65,100.00	1.00
713-09.06	STEEL OVERHEAD SIGN STRUCTURE	EACH	2	$55,100.00	$55,100.00	1.00
			STATE	$55,100.00	$55,100.00	1.00
713-09.07	STEEL OVERHEAD SIGN STRUCTURE	EACH	2	$50,200.00	$50,200.00	1.00
			STATE	$50,200.00	$50,200.00	1.00
713-09.08	STEEL OVERHEAD SIGN STRUCTURE	EACH	2	$50,200.00	$50,200.00	1.00
			STATE	$50,200.00	$50,200.00	1.00
713-09.09	STEEL OVERHEAD SIGN STRUCTURE	EACH	2	$68,300.00	$68,300.00	1.00
			STATE	$68,300.00	$68,300.00	1.00
713-09.10	STEEL OVERHEAD SIGN STRUCTURE	EACH	2	$71,900.00	$71,900.00	1.00
			STATE	$71,900.00	$71,900.00	1.00
713-09.20	STEEL OVERHEAD SIGN STRUCTURE	EACH	1	$82,095.00	$164,190.00	2.00
			3	$67,812.50	$271,250.00	4.00
			STATE	$72,573.33	$435,440.00	6.00
713-09.21	STEEL OVERHEAD SIGN STRUCTURE	EACH	3	$63,250.00	$63,250.00	1.00
			STATE	$63,250.00	$63,250.00	1.00
713-11.01	"U" SECTION STEEL POSTS	LB.	1	$3.16	$92,916.93	29422.00
			2	$3.07	$100,029.15	32576.00
			3	$2.74	$160,989.63	58767.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			4	$3.25	$56,849.08	17491.50
			STATE	$2.97	$410,784.79	138256.50
713-11.02	PERFORATED/KNOCKOUT SQUARE TUBE POST	LB.	1	$3.52	$250,517.06	71240.00
			2	$3.51	$137,907.54	39303.00
			3	$3.27	$316,797.63	96797.87
			4	$3.79	$174,028.18	45912.00
			STATE	$3.47	$879,250.41	253252.87
713-11.03	2 1/2" DIA ROUND STEEL TUBE SIGN POST	LB.	1	$4.46	$2,742.90	615.00
			STATE	$4.46	$2,742.90	615.00
713-11.05	SQUARE TUBE SIGN SUPPORT	LB.	3	$6.30	$2,218.49	352.00
			STATE	$6.30	$2,218.49	352.00
713-11.21	P POST SLIP BASE	EACH	1	$316.67	$950.00	3.00
			2	$474.53	$7,118.00	15.00
			3	$289.59	$40,542.50	140.00
			4	$288.42	$64,605.70	224.00
			STATE	$296.38	$113,216.20	382.00
713-11.22	U POST SLIP BASE	EACH	1	$300.00	$300.00	1.00
			3	$298.03	$13,113.20	44.00
			STATE	$298.07	$13,413.20	45.00
713-11.23	ROUND POST SLIP BASE	EACH	1	$367.50	$5,880.00	16.00
			STATE	$367.50	$5,880.00	16.00
713-13.01	FLAT SHEET ALUMINUM SIGNS (0.064" THICK)	S.F.	4	$14.00	$84.00	6.00
			STATE	$14.00	$84.00	6.00
713-13.02	FLAT SHEET ALUMINUM SIGNS (0.080" THICK)	S.F.	1	$12.75	$96,483.40	7566.00
			2	$12.72	$52,137.35	4099.25
			3	$12.11	$104,642.81	8639.85
			4	$13.20	$79,809.70	6046.00
			STATE	$12.64	$333,073.26	26351.10
713-13.03	FLAT SHEET ALUMINUM SIGNS (0.100" THICK)	S.F.	1	$13.37	$178,242.01	13327.00
			2	$13.20	$149,935.19	11354.50
			3	$12.63	$173,091.29	13706.13
			4	$13.58	$127,080.29	9356.00
			STATE	$13.16	$628,348.78	47743.63
713-13.12	FLAT SHEET ALUM SIGNS OVLY (0.080"THICK)	S.F.	3	$17.50	$1,575.00	90.00
			4	$18.35	$5,505.00	300.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
716-01.14	RAISED PAVEMENT MARKER REMOVAL	EACH	1	$5.50	$1,039.50	189.00
			2	$10.00	$1,500.00	150.00
			3	$5.00	$1,030.00	206.00
			STATE	$6.55	$3,569.50	545.00
716-01.21	SNWPLWBLE PVMT MRKRS (BI-DIR)(1 COLOR)	EACH	1	$25.03	$400,421.04	15996.00
			2	$25.99	$520,291.39	20016.00
			3	$24.96	$844,979.51	33852.00
			4	$36.10	$291,015.60	8061.00
			STATE	$26.39	$2,056,707.54	77925.00
716-01.22	SNPLWBLE PVMT MRKRS (MONO-DIR) (1 COLOR)	EACH	1	$25.26	$131,392.92	5201.00
			2	$28.70	$75,532.05	2632.00
			3	$29.39	$207,410.67	7058.00
			4	$38.25	$222,824.00	5825.00
			STATE	$30.76	$637,159.64	20716.00
716-01.23	SNWPLWBLE PVMT MRKRS (BI-DIR)(2 COLOR)	EACH	1	$25.22	$216,023.84	8567.00
			2	$25.00	$325,528.69	13020.00
			3	$27.27	$389,029.19	14268.00
			4	$40.59	$265,512.95	6541.00
			STATE	$28.21	$1,196,094.67	42396.00
716-01.30	RMVL OF SNOWPLOWABLE REFLECTIVE MARKER	EACH	1	$7.09	$95,763.64	13507.00
			2	$9.88	$196,595.39	19907.00
			3	$9.36	$210,408.38	22468.00
			4	$14.16	$114,305.75	8074.00
			STATE	$9.65	$617,073.16	63956.00
716-01.40	RMV AND RPLC LENS ON SNOWPLW RFLCTV MKR	EACH	1	$3.36	$246,089.80	73188.00
			2	$3.63	$364,400.00	100387.00
			3	$3.35	$160,394.60	47862.00
			4	$3.67	$139,776.00	38129.00
			STATE	$3.51	$910,660.40	259566.00
716-02.03	PLASTIC PAVEMENT MARKING (CROSS-WALK)	L.F.	1	$9.28	$29,173.20	3143.00
			2	$6.65	$33,829.65	5089.00
			3	$9.01	$37,258.00	4133.00
			4	$14.83	$36,524.00	2463.00
			STATE	$9.22	$136,784.85	14828.00
716-02.04	PLASTIC PAVEMENT MARKING (CHNZ STRIPING)	S.Y.	1	$18.34	$197,552.10	10769.00

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			2	$16.40	$217,798.48	13278.00
			3	$10.14	$444,770.93	43865.00
			4	$23.56	$291,815.73	12385.07
			STATE	$14.35	$1,151,937.24	80297.07
716-02.05	PLASTIC PAVEMENT MARKING (STOP LINE)	L.F.	1	$9.33	$201,427.53	21590.00
			2	$10.32	$197,521.01	19136.00
			3	$14.63	$297,923.58	20363.00
			4	$15.24	$180,143.80	11818.00
			STATE	$12.03	$877,015.92	72907.00
716-02.06	PLASTIC PAVEMENT MKG (TURN LANE ARROW)	EACH	1	$129.82	$126,830.32	977.00
			2	$138.05	$97,048.00	703.00
			3	$156.54	$195,669.36	1250.00
			4	$182.10	$108,898.73	598.00
			STATE	$149.79	$528,446.41	3528.00
716-02.07	PLASTIC PAVEMENT MKG (24" BARRIER LINE)	L.F.	1	$6.62	$25,310.92	3825.00
			2	$7.44	$11,641.75	1565.00
			3	$7.74	$97,768.00	12630.00
			4	$18.07	$144,481.80	7995.00
			STATE	$10.73	$279,202.47	26015.00
716-02.08	PLASTIC PAVEMENT MKG (8" DOTTED LINE)	L.F.	1	$1.91	$10,001.70	5250.00
			2	$1.83	$11,600.95	6354.00
			3	$2.20	$19,608.00	8927.00
			4	$3.00	$10,974.35	3659.00
			STATE	$2.16	$52,185.00	24190.00
716-02.09	PLASTIC PVMT MKG (LONGITUDINAL X-WALK)	L.F.	1	$19.56	$101,557.13	5193.00
			2	$23.30	$31,803.50	1365.00
			3	$27.60	$256,276.59	9285.00
			4	$38.64	$100,992.16	2614.00
			STATE	$26.58	$490,629.38	18457.00
716-02.11	PLASTIC PAVEMENT MKG (6" DOTTED LINE)	L.F.	1	$1.15	$2,062.00	1798.00
			2	$1.58	$4,556.88	2889.00
			3	$2.00	$2,076.00	1038.00
			4	$2.00	$18,982.00	9491.00
			STATE	$1.82	$27,676.88	15216.00
716-02.12	PLASTIC PAVEMENT MARKING (8IN LINE)	L.M.	1	$6,419.96	$8,987.95	1.40

Item Number	Description	Unit of Measure	Region	Average Unit Price	Total Cost	Total Quantity
			3	$250.07	$2,000.55	8.00
			STATE	$730.70	$10,960.55	15.00
798-13.04	STRAND ANGLE ASSEMBLY	EACH	2	$1,280.00	$1,280.00	1.00
			STATE	$1,280.00	$1,280.00	1.00
798-13.07	STRAND DOUBLE DEADEND ASSEMBLY	EACH	2	$1,390.00	$11,120.00	8.00
			3	$272.04	$1,360.20	5.00
			STATE	$960.02	$12,480.20	13.00
798-13.08	STRAND DEADEND ASSEMBLY	EACH	2	$1,280.00	$11,520.00	9.00
			STATE	$1,280.00	$11,520.00	9.00
801-01	SEEDING (WITH MULCH)	UNIT	1	$12.58	$19,768.10	1572.00
			2	$50.16	$19,546.60	389.65
			3	$34.94	$117,491.57	3363.10
			4	$41.76	$17,958.70	430.00
			STATE	$30.37	$174,764.97	5754.75
801-01.02	CROWN VETCH MIXTURE (WITH MULCH)	UNIT	1	$115.65	$3,990.00	34.50
			2	$59.36	$59.36	1.00
			3	$93.55	$8,466.00	90.50
			STATE	$99.33	$12,515.36	126.00
801-01.06	SEEDING (SPECIAL MIXTURE)	UNIT	3	$125.00	$3,250.00	26.00
			STATE	$125.00	$3,250.00	26.00
801-01.07	TEMPORARY SEEDING (WITH MULCH)	UNIT	1	$42.83	$163,690.00	3822.00
			2	$29.57	$33,145.03	1121.04
			3	$29.16	$215,157.93	7378.00
			4	$21.36	$311,227.00	14573.00
			STATE	$26.89	$723,219.96	26894.04
801-01.08	SEEDING (SPECIAL MIXTURE) WITH MULCH	UNIT	3	$79.20	$9,504.00	120.00
			STATE	$79.20	$9,504.00	120.00
801-01.16	BONDED FIBER MATRIX HY(W/PERMANENT SEED)	UNIT	1	$143.81	$25,885.00	180.00
			STATE	$143.81	$25,885.00	180.00
801-01.30	COVER CROP SEED MIX (RIPZN/FLPL) W/MULCH	UNIT	3	$125.00	$1,750.00	14.00
			STATE	$125.00	$1,750.00	14.00
801-01.34	GRASS SEED MIX (RIPZN/FLPL)	UNIT	2	$250.00	$250.00	1.00
			4	$290.81	$2,908.10	10.00
			STATE	$287.10	$3,158.10	11.00
801-01.36	SPECIAL WETLAND SEED MIXTURE	UNIT	4	$100.00	$13,400.00	134.00

REINFORCED CONCRETE PIPE

FRED WEBER REINFORCED CONCRETE PRODUCTS
Michael Ax (314) 892-7400
St. Louis, MO

CIRCULAR REINFORCED CONCRETE PIPE

SIZE	CLASS II PER FOOT	CLASS III PER FOOT	CLASS IV PER FOOT
12 INCH	NO BID	$8.80	$8.80
15 INCH		$11.80	$12.40
18 INCH		$15.75	$16.30
24 INCH		$23.75	$26.75
30 INCH		$32.00	$36.15
36 INCH		$45.50	$52.50
42 INCH		$58.00	$70.50
48 INCH		$76.50	$82.00
54 INCH		$103.10	$118.70
60 INCH		$123.90	$150.00
72 INCH		$183.60	$225.00
78 INCH		$248.00*	$276.00*
84 INCH		$270.00*	$308.00*
90 INCH		$320.00*	$436.00*
96 INCH		$356.00*	$590.00*
108 INCH		$515.00*	$600.00*

*Call for availability

CIRCULAR CONCRETE FLARED END SECTIONS

SIZE	EACH
12 INCH	$302.50
15 INCH	$313.50
18 INCH	$341.00
24 INCH	$451.00
30 INCH	$638.00
36 INCH	$940.00
42 INCH	$1,089.00
48 INCH	$1,138.50
54 INCH	$1,677.50
60 INCH	$2,403.50
72 INCH	$4,218.50
78 INCH	$4,702.50
84 INCH	$5,362.50
90 INCH	NO BID
96 INCH	NO BID
108 INCH	NO BID

*Pricing based on full loads delivered. Partial load subject to $200 small load fee. Pricing good for pick-up in Fulton, MO.

Table 5A-1. Sign and Plaque Sizes on Low-Volume Roads (Sheet 1 of 2)

Sign or Plaque	Sign Designation	Section	Sign Sizes		
			Typical	Minimum	Oversized
Stop	R1-1	5B.02	30 x 30	—	36 x 36
Yield	R1-2	5B.02	30 x 30 x 30	—	36 x 36 x 36
Speed Limit (English)	R2-1	5B.03	24 x 30	18 x 24	36 x 48
Do Not Pass	R4-1	5B.04	24 x 30	—	36 x 48
Pass With Care	R4-2	5B.04	24 x 30	18 x 24	36 x 48
Keep Right	R4-7	5B.04	24 x 30	18 x 24	36 x 48
Do Not Enter	R5-1	5B.04	30 x 30	—	36 x 36
No Trucks	R5-2	5B.04	24 x 24	—	30 x 30
One Way	R6-2	5B.04	18 x 24	—	24 x 30
No Parking (symbol)	R8-3	5B.05	24 x 24	18 x 18	30 x 30
No Parking	R8-3a	5B.05	18 x 24	—	24 x 30
No Parking (plaque)	R8-3cP,3dP	5B.05	24 x 18	18 x 12	30 x 24
Road Closed	R11-2	5B.04	48 x 30	—	—
Road Closed, Local Traffic Only	R11-3a	5B.04	60 x 30	—	—
Bridge Out, Local Traffic Only	R11-3b	5B.04	60 x 30	—	—
Road Closed to Thru Traffic	R11-4	5B.04	60 x 30	—	—
Weight Limit	R12-1	5B.04	24 x 30	—	36 x 48
Grade Crossing (Crossbuck)	R15-1	5F.02	48 x 9	—	—
Number of Tracks (plaque)	R15-2P	5F.02	27 x 18	—	—
Horizontal Alignment	W1-1,2,3,4,5	5C.02	30 x 30	—	36 x 36
One-Direction Large Arrow	W1-6	5C.02	36 x 18	—	48 x 24
Two-Direction Large Arrow	W1-7	5C.02	36 x 18	—	48 x 24
Chevron Alignment	W1-8	5C.02	12 x 18	—	18 x 24
Intersection Warning	W2-1,2,3,4,5,6	5C.03	30 x 30	—	36 x 36
Stop Ahead	W3-1	5C.04	30 x 30	—	36 x 36
Yield Ahead	W3-2	5C.04	30 x 30	—	36 x 36
Be Prepared to Stop	W3-4	5G.05	36 x 36	—	48 x 48
Narrow Bridge	W5-2	5C.05	30 x 30	—	36 x 36
One Lane Bridge	W5-3	5C.06	30 x 30	—	36 x 36
Hill	W7-1	5C.07	30 x 30	—	36 x 36
XX % Grade (plaque)	W7-3P	5C.07	24 x 18	—	30 x 24
Next XX Miles (plaque)	W7-3aP	5C.09	24 x 18	—	30 x 24
Pavement Ends	W8-3	5C.08	30 x 30	—	36 x 36
Truck Crossing	W8-6	5C.09	30 x 30	—	36 x 36
Loose Gravel	W8-7	5G.05	30 x 30	—	36 x 36
Rough Road	W8-8	5G.05	30 x 30	—	36 x 36
Road May Flood	W8-18	5G.05	30 x 30	—	36 x 36
Grade Crossing Advance Warning	W10-1	5F.03	30 Dia.	—	36 Dia.
Grade Crossing Advance Warning	W10-2,3,4	5F.03	30 x 30	—	36 x 36
Trains May Exceed 80 mph	W10-8	5F.06	30 x 30	—	36 x 36
Storage Space Symbol	W10-11	5F.06	30 x 30	—	36 x 36
Skewed Crossing	W10-12	5F.06	30 x 30	—	36 x 36
Entering/Crossing	W11 Series	5C.09	30 x 30	—	36 x 36
Advisory Speed (plaque)	W13-1P	5C.10	18 x 18	—	24 x 24
Dead End/No Outlet	W14-1,2	5C.11	30 x 30	—	36 x 36
Dead End/No Outlet	W14-1a,2a	5C.11	36 x 9	24 x 6	—

Cut/Fill Report

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By user: CEESDL
Drawing: C:\Users\CEESDL\Downloads\C:\Users\CEESDL\Downloads\C103 FINAL.dwg

Volume Summary							
Name	**Type**	**Cut Factor**	**Fill Factor**	**2d Area** (Sq. Ft.)	**Cut** (Cu. Yd.)	**Fill** (Cu. Yd.)	**Net** (Cu. Yd.)
PGrade vs EG	full	1.000	1.000	639397.17	8143.71	272239.40	264095.69<Fill>

Totals				
	2d Area (Sq. Ft.)	**Cut** (Cu. Yd.)	**Fill** (Cu. Yd.)	**Net** (Cu. Yd.)
Total	639397.17	8143.71	272239.40	264095.69<Fill>

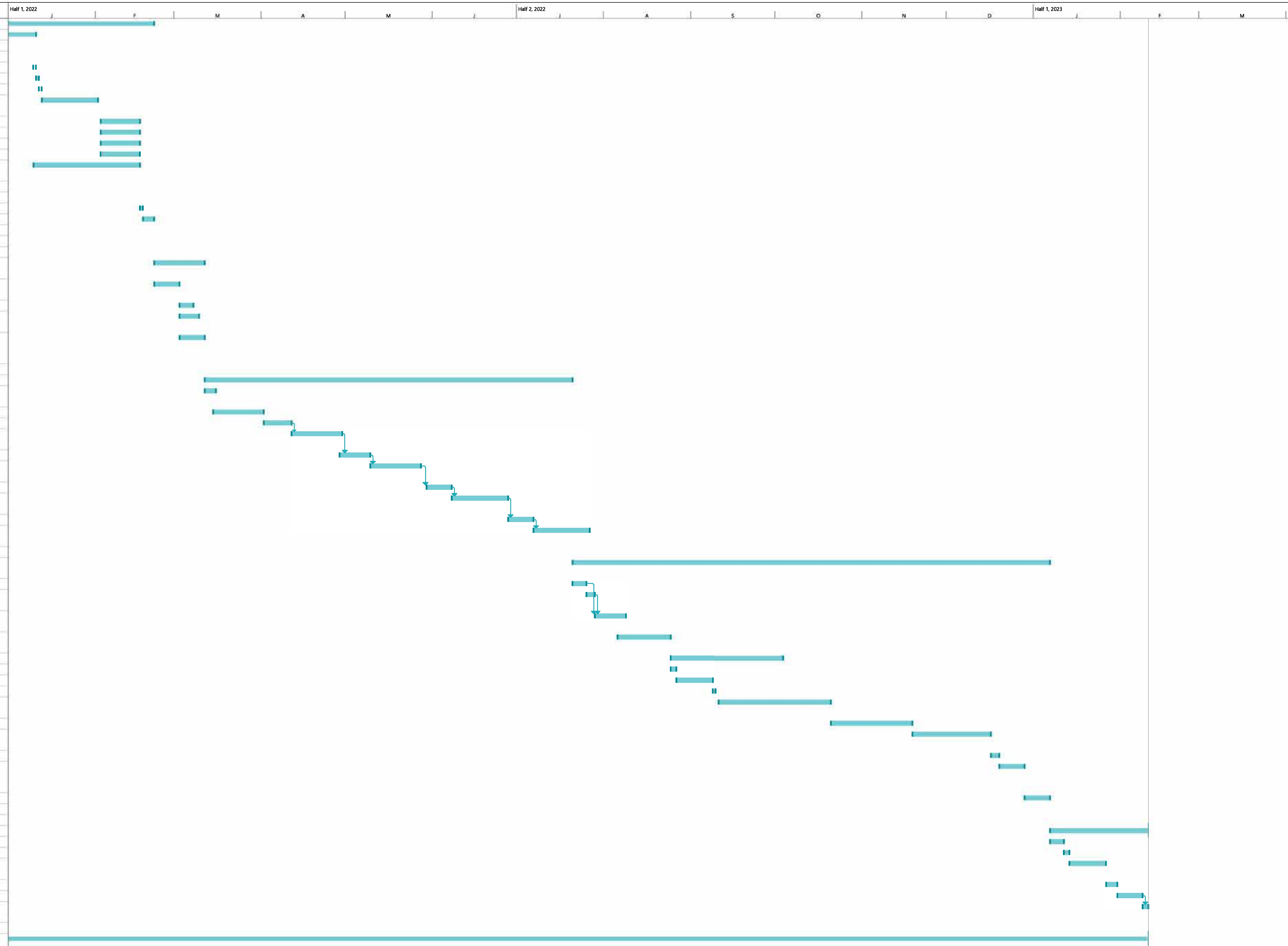
* Value adjusted by cut or fill factor other than 1.0

Material	Sub Material				Quantiy of Material	Material Unit	Price per Unit	Price		
Concrete										
	Terminal	Class A			6.30	yd^3	$800.00	$5,040.00		
	Parking Cover	Class A			41.00	yd^3	$800.00	$32,800.00		
	Hangars	Class A			578.23	yd^3	$800.00	$462,584.00		
								$500,424.00		
	PIPE ID	DIA (ft)	LENGTH	Whole Length	Quantity of Material					
	PIPE- 44 Class III	108" (9)	156.18'	157.00	20.00	each	$515.00	$80,855.00		
	PIPE - 45 Class III	108" (9)	207.21'	208.00	26.00	each	$515.00	$107,120.00		
	PIPE- 35 Class III	108" (9)	184'	184.00	23.00	each	$515.00	$94,760.00		
	PIPE -36 Class III	108" (9)	205'	205.00	26.00	each	$515.00	$105,575.00		
	PIPE-42 Class III	84" (7)	241.4'	242.00	21.00	each	$270.00	$65,340.00		
	PIPE-43 Class III	84" (7)	295.42'	296.00	37.00	each	$270.00	$79,920.00		
	PIPE -43 (1) Class III	84" (7)	39'	39.00	5.00	each	$270.00	$10,530.00		
	PIPE -40 Class III	60" (5)	132.44'	132.00	17.00	each	$264.27	$34,883.64		
								$578,983.64		
	TYPE:	RECTANGULAR 2 TEIR STRUCTURE							Prefab Size (ft^2)	Prefab Cost
	STRUCTURE NO	RIM ELV	SUMP	FRAME HEIGHT	FRAME LENGTH	FRAME WIDTH	INNER STRUCT	INNER STRUCTURE WIDTH		
	66.00	930.00	909.00	4"	18"	18"	72"	72"	180.00	$350.00
	1.00	930.00	892.86	4"	18"	18"	144"	144"	720.00	$350.00
	69.00	930.00	904.00	4"	18"	18"	96"	96"	620.00	$350.00
	77.00	930.00	884.00	4"	18"	18"	144"	144"	720.00	$350.00
	71.00	930.00	884.00	4"	18"	18"	144"	144"	720.00	$350.00
	60.00	930.00	876.00	4"	18"	18"	144"	144"	720.00	$350.00
	72.00	930.00	877.00	4"	18"	18"	144"	144"	720.00	$350.00
	76.00	888.50	876.00	4"	18"	18"	96"	96"	620.00	$350.00
								Total		
	Concrete Total Cost							$2,836,407.64		
Asphalt										
	Road		10071.00	ft^2	145	lb/ft^3				
			3776.63	ft^3	273.81	tons	$84.74	$23,202.26		
	Signage									
		Street Signs (0.08" Thick)				ft^2	$12.75			
		Stop Sign (0.08" Thick)	30"x30"		8.84	each	$12.75	$112.68		
		Road Bend Sign (0.08" Thick)	30"x30"		12.50	ft^2	$12.75	$159.38		
		"U" Section Steel Post			96	lb	$3.16	$303.36		
	Parking Lot		36850.00	ft^2	1001.86	tons	$84.74	$84,897.56		
	Slab		245600.00	ft^2	6677.25	tons	$84.74	$565,830.17		
	Pavement Markings									
		Stop Line			39.00	ft^2	$9.33	$363.87		
		Cross Walk			0.00	ft	$9.28	$0.00		
		Turn Sign			15.00	each	$129.82	$1,947.30		
		24" Center Line			300.00	ft	$6.62	$1,986.00		
		8" Dotted Line			50.00	ft	$1.91	$95.50		
	ABC Stone		4196.25	ft^3	205.62	ton	$23.05	$4,739.45		
							Total Cost	$683,637.53		
Land								Total Loads		
	On-site				345040.00	yd^3		34504	truck loads	
	Hauling Trucks				10.00	yd^3	$600.00	$873,600.00	for 56 days	
	Surveying				48.00	acre	$600.00	$28,800.00		
	Silt Fence				6000.00	ft	$3.95	$23,700.00		
	Tree Fence				2845.00	ft	$2.06	$5,860.70		
	Seeding	30 lbs/acre			48.00	acre	$12.58	$18,115.20		
	Security Fence	6 ft tall			5550.00	ft	$11.99	$66,544.50		
		fence gate			1	each	$1,160.00	$1,160.00		
	Rock Check Dams				10.00	each	$239.91	$2,399.10		
	Soil				264100.00	yd^3	$5.89	$1,555,549.00		
							Total Cost	$2,575,728.50		
Steel		# of Material					lb/ft	total pounds	tons	cost
Terminal	A-992 WF									
	W14x43 (2 beams)	2.00	25'2"	25.17	50.33	ft	43.00	2164.33	1.08	$10,821.67
	W14x22 (2 beams)	2.00	28'9"	28.75	59.40	ft	22.00	1306.80	0.65	$6,534.00
	W12x45 (2 beams)	2.00	24'6"	24.45	48.90	ft	45.00	2200.50	1.10	$11,002.50
	A500 Gr. B HSS									
	8x8x3/16 (6 beams at 12'0")	6.00	12'0"	12.00	72.00	ft	19.63	1413.36	0.71	$7,066.80
Parking Cover	A-992 WF									
	W21x44	48.00	29'0"	29.00	1392.00	ft	44.00	61248.00	30.62	$306,240.00
	W21x68	8.00	20'0"	20.00	160.00	ft	68.00	10880.00	5.44	$54,400.00
	A500 Gr. B HSS									
	9x9x8	20.00	7'1'	7.07	141.40	ft	55.66	7870.32	3.94	$39,351.62
	4x4x4	20.00	5'	5.00	100.00	ft	12.21	1221.00	0.61	$6,105.00
Hangars	A-992 WF									
	W10x39	57.00	19'1"	19.05	1086.00	ft	39.00	42354.00	21.18	$211,770.00
	W16x36	42.00	24'	24.00	1008.00	ft	36.00	36288.00	18.14	$181,440.00
	W24x76	6.00	33'	33.00	198.00	ft	76.00	15048.00	7.52	$75,240.00
	W27x114	48.00	42'	42.00	2016.00	ft	114.00	229824.00	114.91	$1,149,120.00
	A500 Gr. B HSS									
	8x8x4	18.00	16'	16.00	288.00	ft	25.82	7436.16	3.72	$37,180.80
	8x8x8	135.00	16'	16.00	2160.00	ft	48.85	105516.00	52.76	$527,580.00
										$2,623,852.39
Steel Total										
	A-992 WF Total	213.00	245'5"	245.42	5969.73	ft				$2,006,568.17
	A500 Gr. B HSS Total	179.00	56'1"	56.07	2661.40	ft				$617,284.22
	Anchor Bolts	796.00			796.00	LS				$1,464,640.00
										$4,088,492.39
Total Costs										
Concrete	$2,836,407.64									
Roadways	$683,637.53									
Land	$2,575,728.50									
Steel	$4,088,492.39									
	$10,184,266.06									

Material	Sub Material		Reference Page			
Concrete						
	Terminal	Class A	TDOT pg. 32			
	Parking Cover	Class A	TDOT pg. 32			
	Hangars	Class A	TDOT pg. 32			
	PIPE ID	DIA (ft)				
	PIPE- 44 Class III	108" (9)	Cole County pg. 8			
	PIPE - 45 Class III	108" (9)	Cole County pg. 8			
	PIPE- 35 Class III	108" (9)	Cole County pg. 8			
	PIPE -36 Class III	108" (9)	Cole County pg. 8			
	PIPE-42 Class III	84" (7)	Cole County pg. 8			
	PIPE-43 Class III	84" (7)	Cole County pg. 8			
	PIPE -43 (1) Class III	84" (7)	Cole County pg. 8			
	PIPE -40 Class III	60" (5)	TDOT pg. 43			
	TYPE:	RECTANGULAR 2 TEIR STRUCTURE		references		
	STRUCTURE NO	RIM ELV				
	66.00	930.00	$63,000.00	https://precast.org/2010/05/wh		
	1.00	930.00	$252,000.00	https://precast.org/2010/05/		
	69.00	930.00	$217,000.00	https://precast.org/2010/05/wh		
	77.00	930.00	$252,000.00	https://precast.org/2010/05/wh		
	71.00	930.00	$252,000.00	https://precast.org/2010/05/wh		
	60.00	930.00	$252,000.00	https://precast.org/2010/05/wh		
	72.00	930.00	$252,000.00	https://precast.org/2010/05/wh		
	76.00	888.50	$217,000.00	https://precast.org/2010/05/wh		
			$1,757,000.00			
	Concrete Total Cost					
Asphalt						
	Road					
			TDOT pg. 19			
	Signage					
		Street Signs (0.08" Thick)	TDOT pg. 115			
		Stop Sign (0.08" Thick)	TDOT pg. 115			
		Road Bend Sign (0.08" Thick)	TDOT pg. 115			
		"U" Section Steel Post	TDOT pg. 114			
	Parking Lot		TDOT pg. 19			
	Slab		TDOT pg. 19			
	Pavement Markings					
		Stop Line	TDOT pg. 131			
		Cross Walk	TDOT pg. 130			
		Turn Sign	TDOT pg. 131			
		24" Center Line	TDOT pg. 131			
		8" Dotted Line	TDOT pg. 131			
	ABC Stone		TDOT pg. 18			
Land						
	On-site					
	Hauling Trucks		https://www.unitedrentals.com/market			
	Surveying					
	Silt Fence		TDOT pg. 14			
	Tree Fence		TDOT pg. 102			
	Seeding	30 lbs/acre	TDOT pg 215			
	Security Fence	6 ft tall	TDOT pg 101			
		fence gate	TDOT pg 101			
	Rock Check Dams		TDOT pg 14			
	Soil		TDOT pg 8			
Steel		# of Material		Anchor Bolts (TDOT pg. 29)	cost	
Terminal	A-992 WF				$1,840.00	TDOT pg. 29
	W14x43 (2 beams)	2.00	TDOT pg. 28			
	W14x22 (2 beams)	2.00	TDOT pg. 28			
	W12x45 (2 beams)	2.00	TDOT pg. 28			
	A500 Gr. B HSS					
	8x8x3/16 (6 beams at 12'0")	6.00	TDOT pg. 28	24.00	$44,160.00	TDOT pg 29
Parking Cover	A-992 WF					
	W21x44	48.00	TDOT pg. 28			
	W21x68	8.00	TDOT pg. 28			
	A500 Gr. B HSS					
	9x9x8	20.00	TDOT pg. 28	80.00	$147,200.00	TDOT pg 29
	4x4x4	20.00	TDOT pg. 28	80.00	$147,200.00	TDOT pg 29
Hangars	A-992 WF					
	W10x39	57.00	TDOT pg. 28			
	W16x36	42.00	TDOT pg. 28			
	W24x76	6.00	TDOT pg. 28			
	W27x114	48.00	TDOT pg. 28			
	A500 Gr. B HSS					
	8x8x4	18.00	TDOT pg. 28	72.00	$132,480.00	TDOT pg 29
	8x8x8	135.00	TDOT pg. 28	540.00	$993,600.00	TDOT pg 29
			TDOT pg. 28		$1,464,640.00	TDOT pg. 29
Steel Total						
	A-992 WF Total	213.00				
	A500 Gr. B HSS Total	179.00				
	Anchor Bolts	796.00				
Total Costs						
Concrete	$2,836,407.64					
Roadways	$683,637.53					
Land	$2,575,728.50					
Steel	$4,088,492.39					
	$10,184,266.06					

Material	Sub Material		
Concrete			
	Terminal	Class A	
	Parking Cover	Class A	
	Hangars	Class A	
	PIPE ID	DIA (ft)	
	PIPE- 44 Class III	108" (9)	
	PIPE - 45 Class III	108" (9)	
	PIPE- 35 Class III	108" (9)	
	PIPE -36 Class III	108" (9)	
	PIPE-42 Class III	84" (7)	
	PIPE-43 Class III	84" (7)	
	PIPE -43 (1) Class III	84" (7)	
	PIPE -40 Class III	60" (5)	
	TYPE:	RECTANGULAR 2 TEIR STRUCTURE	
	STRUCTURE NO	RIM ELV	
	66.00	930.00	
	1.00	930.00	
	69.00	930.00	
	77.00	930.00	
	71.00	930.00	
	60.00	930.00	
	72.00	930.00	
	76.00	888.50	
	Concrete Total Cost		
Asphalt			
	Road		
	Signage		
		Street Signs (0.08" Thick)	
		Stop Sign (0.08" Thick)	
		Road Bend Sign (0.08" Thick)	
		"U" Section Steel Post	
	Parking Lot		
	Slab		
	Pavement Markings		
		Stop Line	
		Cross Walk	
		Turn Sign	
		24" Center Line	
		8" Dotted Line	
	ABC Stone		
Land			
	On-site		
	Hauling Trucks		
	Surveying		
	Silt Fence		
	Tree Fence		
	Seeding	30 lbs/acre	
	Security Fence	6 ft tall	
		fence gate	
	Rock Check Dams		
	Soil		
Steel		# of Material	
Terminal	A-992 WF		
	W14x43 (2 beams)	2.00	
	W14x22 (2 beams)	2.00	
	W12x45 (2 beams)	2.00	
	A500 Gr. B HSS		
	8x8x3/16 (6 beams at 12'0")	6.00	
Parking Cover	A-992 WF		
	W21x44	48.00	
	W21x68	8.00	
	A500 Gr. B HSS		
	9x9x8	20.00	
	4x4x4	20.00	
Hangars	A-992 WF		
	W10x39	57.00	
	W16x36	42.00	
	W24x76	6.00	
	W27x114	48.00	
	A500 Gr. B HSS		
	8x8x4	18.00	
	8x8x8	135.00	
Steel Total			
	A-992 WF Total	213.00	
	A500 Gr. B HSS Total	179.00	
	Anchor Bolts	796.00	
Total Costs			
Concrete	$2,836,407.64		
Roadways	$683,637.53		
Land	$2,575,728.50		
Steel	$4,088,492.39		
	$10,184,266.06		

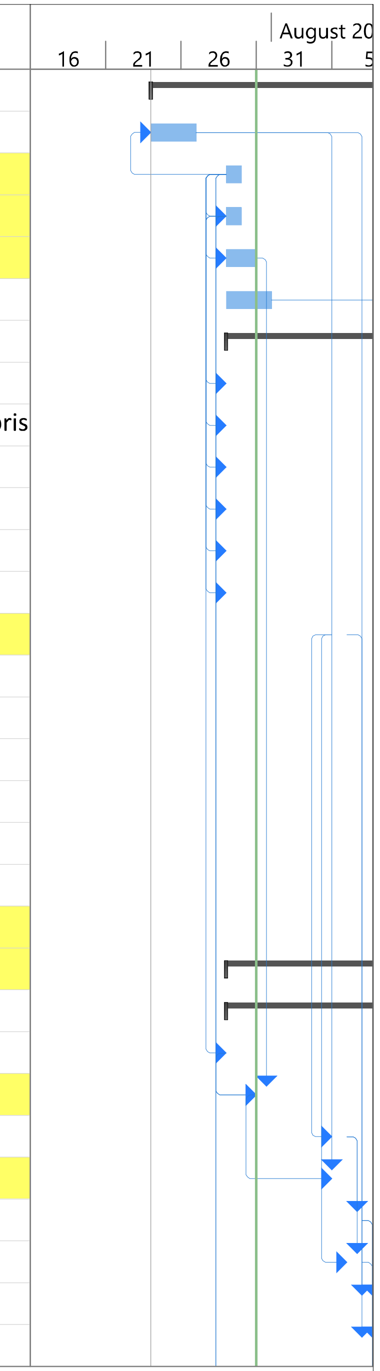
ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		Preconstruction	37 days	Sat 1/1/22	Mon 2/21/22		
2		Bonds and insurance	7 days	Sat 1/1/22	Mon 1/10/22		
3							
4		Submittals					
5		Construction Plan	1 day	Mon 1/10/22	Mon 1/10/22		
6		Quality Control Plan	1 day	Tue 1/11/22	Tue 1/11/22		
7		Schedule	1 day	Wed 1/12/22	Wed 1/12/22		
8		RCP Submittal and Procurement	14 days	Thu 1/13/22	Tue 2/1/22		
9		Precast Drainage	10 days	Thu 2/3/22	Wed 2/16/22		
10		Electrical Submittal	10 days	Thu 2/3/22	Wed 2/16/22		
11		Asphalt Submittal	10 days	Thu 2/3/22	Wed 2/16/22		
12		Steel Submittal	10 days	Thu 2/3/22	Wed 2/16/22		
13		Concrete Mix Submittal	28 days	Mon 1/10/22	Wed 2/16/22		
14							
15		Site					
16		Barricades	1 day	Thu 2/17/22	Thu 2/17/22		
17		Erosion Control	2 days	Fri 2/18/22	Mon 2/21/22		
18							
19							
20		Construction					
21		Phase 1A Administrative	14 days	Tue 2/22/22	Fri 3/11/22		
22		Contractor Mobilization	7 days	Tue 2/22/22	Wed 3/2/22		
23		Locate Utilities	3 days	Thu 3/3/22	Mon 3/7/22		
24		Survey Control Points	5 days	Thu 3/3/22	Wed 3/9/22		
25		Staging and Construction Entrances	7 days	Thu 3/3/22	Fri 3/11/22		
26							
27		Phase 1B Earth Work	94 days	Sat 3/12/22	Wed 7/20/22		
28		Relocate Perimeter Fence	3 days	Sat 3/12/22	Tue 3/15/22		
29		Demolition	14 days	Tue 3/15/22	Fri 4/1/22		
30		Strip Topsoil	7 days	Sat 4/2/22	Mon 4/11/22		
31		Fill & Compact Soil for 9' RCP	14 days	Tue 4/12/22	Fri 4/29/22	30	
32		Install 9' RCP	7 days	Fri 4/29/22	Mon 5/9/22	31	
33		Fill & Compact Soil for 7' RCP	14 days	Tue 5/10/22	Fri 5/27/22	32	
34		Install 7' RCP	7 days	Mon 5/30/22	Tue 6/7/22	33	
35		Fill & Compact Soil for 5' RCP	14 days	Wed 6/8/22	Mon 6/27/22	34	
36		Install 5' RCP	7 days	Tue 6/28/22	Wed 7/6/22	35	
37		Fill & Compact to Grade	14 days	Thu 7/7/22	Tue 7/26/22	36	
38							
39		Phase 2 Hangars, Parking, Roadway	122 days	Thu 7/21/22	Fri 1/6/23		
40		Fine Grade Roadway	3 days	Thu 7/21/22	Mon 7/25/22		
41		Fine Grade Parking and Hangar Space	3 days	Tue 7/26/22	Thu 7/28/22		
42		Excavate Foundations	7 days	Fri 7/29/22	Mon 8/8/22	40,41	
43		Formwork and Pouring	14 days	Sat 8/6/22	Wed 8/24/22		
44		Concrete Curing	28 days	Thu 8/25/22	Mon 10/3/22		
45		Tempory Seeding	2 days	Thu 8/25/22	Fri 8/26/22		
46		Steel Produrement	10 days	Sat 8/27/22	Thu 9/8/22		
47		Crane Mobilization	1 day	Fri 9/9/22	Fri 9/9/22		
48		Steel Column Install	30 days	Sun 9/11/22	Thu 10/20/22		
49		Steel Beam Install	21 days	Fri 10/21/22	Fri 11/18/22		
50		Hangar and Office Façade	21 days	Sat 11/19/22	Fri 12/16/22		
51		ABC Stone for Road	2 days	Sat 12/17/22	Mon 12/19/2		
52		ABC Stone for Parking Lot and Hangar Space	7 days	Tue 12/20/22	Wed 12/28/22		
53		Asphalt	7 days	Thu 12/29/2	Fri 1/6/23		
54							
55							
56		Post Construction	26 days	Sat 1/7/23	Fri 2/10/23		
57		Seeding	4 days	Sat 1/7/23	Wed 1/11/23		
58		Site Clean Up	2 days	Thu 1/12/23	Fri 1/13/23		
59		Contractor Mobilization	10 days	Sat 1/14/23	Thu 1/26/23		
60		Signage	2 days	Fri 1/27/23	Mon 1/30/23		
61		Fencing Installation	7 days	Tue 1/31/23	Wed 2/8/23		
62		Walk Through and Punchlist	2 days	Thu 2/9/23	Fri 2/10/23	61	
63							
64		Total Schedule Length	291 days	Sat 1/1/22	Fri 2/10/23		



Project: Project1
Date: Mon 4/26/21

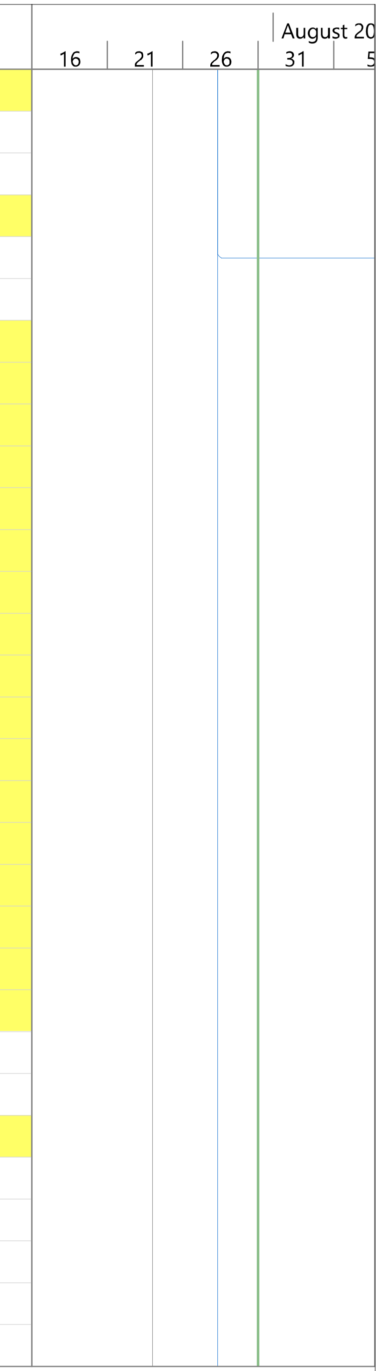
Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

ID	Task Name	Duration	Start	Finish	Total Slack	Task Calendar	Responsibility
1	**Preconstruction**	**61 days**	**Wed 7/24/19**	**Thu 10/17/19**	**3 days**	**5-Day**	
3	Utility Locate - TW "B", B4, B5 and "Y"	3 days	Wed 7/24/19	Fri 7/26/19	5 days	5-Day	Harper
2	Project 4 NTP	1 day	Mon 7/29/19	Mon 7/29/19	0 days	5-Day	MKAA
4	Install Barricades	1 day	Mon 7/29/19	Mon 7/29/19	0 days	5-Day	Harper
5	Install Erosion Control Devices	2 days	Mon 7/29/19	Tue 7/30/19	0 days	5-Day	Harper
6	Utility Locate - TW G & G4	3 days	Mon 7/29/19	Wed 7/31/19	13 days	5-Day	Harper
9	**Submittals**	**28 days**	**Mon 7/29/19**	**Thu 9/5/19**	**4 days**	**5-Day**	
10	Electrical Submittals	10 days	Mon 7/29/19	Fri 8/9/19	4 days	5-Day	Airfield Etc.
11	Drainage Submittals	10 days	Mon 7/29/19	Fri 8/9/19	46 days	5-Day	Harper, Bunn Enterpris
12	Asphalt Submittals	10 days	Mon 7/29/19	Fri 8/9/19	115 days	5-Day	Rogers Group
13	Concrete Mix Design Submittals	28 days	Mon 7/29/19	Thu 9/5/19	23 days	5-Day	Harper
14	Concrete Accessory Submittals	10 days	Mon 7/29/19	Fri 8/9/19	51 days	5-Day	Harper
15	Lime Submittals	10 days	Mon 7/29/19	Fri 8/9/19	27 days	5-Day	Pozzolanic
7	Shut down TW "Y"	1 day	Mon 8/5/19	Mon 8/5/19	0 days	5-Day	MKAA
16	**Material Lead Times**	**48 days**	**Mon 8/12/19**	**Thu 10/17/19**	**4 days**	**5-Day**	
17	Electrical Manholes	30 days	Mon 8/12/19	Mon 9/23/19	4 days	5-Day	Airfield Etc.
18	Drainage Structures	30 days	Mon 8/12/19	Mon 9/23/19	134 days	5-Day	Harper
20	NEMA Enclosures for RTR Work	30 days	Mon 8/12/19	Mon 9/23/19	14 days	5-Day	Airfield Etc.
21	RTR Cable	15 days	Mon 8/12/19	Fri 8/30/19	33 days	5-Day	Airfield Etc.
19	Concrete Accessories	30 days	Fri 9/6/19	Thu 10/17/19	23 days	5-Day	Harper
8	Open TW "B2"-"G3" Taxi Route	1 day	Mon 8/19/19	Mon 8/19/19	0 days	5-Day	MKAA
22	**Construction (330 Calendar Days)**	**181 days**	**Mon 7/29/19**	**Mon 6/22/20**	**0 days**	5-Day	
24	**TW "B" & Connectors**	**170 days**	**Mon 7/29/19**	**Fri 6/5/20**	**2 days**	**5-Day**	
25	Electrical Demo - Remove Fixtures Pull Cable, Pull Light Cans	3 days	Mon 7/29/19	Wed 7/31/19	2 days	5-Day	Airfield Etc.
27	Strip Topsoil	5 days	Wed 7/31/19	Tue 8/6/19	0 days	5-Day	Harper
26	Install Temporary Jumpers on TW "Y"	1 day	Mon 8/5/19	Mon 8/5/19	17 days	5-Day	Airfield Etc.
28	Unclassified Excavation	20 days	Mon 8/5/19	Fri 8/30/19	0 days	5-Day	Harper
46	Electrical Demo - TW "Y" - Remove Fixtures Pull Cable, Pull Light Cans	1 day	Tue 8/6/19	Tue 8/6/19	17 days	5-Day	Airfield Etc.
58	Sawcut Existing Concrete - TW "Y"	1 day	Tue 8/6/19	Tue 8/6/19	18 days	5-Day	Harper
45	Break Existing Concrete (12" DEEP) - TW "Y"	3 days	Wed 8/7/19	Fri 8/9/19	18 days	5-Day	Harper
48	Demo Asphalt Shoulders & Base on TWs "B" and "Y"- 5" Asphalt on 8" Rock	4 days	Wed 8/7/19	Mon 8/12/19	17 days	5-Day	Harper



ID	Task Name	Duration	Start	Finish	Total Slack	Task Calendar	Responsibility
59	Demo Existing Sign Pads - TW "Y"	1 day	Wed 8/7/19	Wed 8/7/19	148 days	5-Day	Airfield Etc.
49	Remove Concrete & Base (12" PCC ON 8" ROCK) - TW "Y"	3 days	Tue 8/13/19	Thu 8/15/19	17 days	5-Day	Harper
29	Install Electrical Duct Banks	12 days	Tue 9/3/19	Mon 9/16/19	0 days	6-Day	Airfield Etc.
57	Demo Existing Duct Banks - TW "Y"	2 days	Mon 9/9/19	Tue 9/10/19	0 days	5-Day	Airfield Etc.
30	Trim Pre-Lime Subgrade	6 days	Wed 9/11/19	Wed 9/18/19	0 days	5-Day	Harper
61	Install Junction Can Plazas & New Sign Foundations	7 days	Tue 9/17/19	Wed 9/25/19	114 days	5-Day	Airfield Etc.
31	12" Lime Treated Subgrade	12 days	Thu 9/19/19	Fri 10/4/19	0 days	5-Day	Pozzolanic
32	12" Lime Cure Time	23 days	Sat 9/21/19	Sun 10/13/19	5 days	Calendar Day	Pozzolanic
33	6" Lime Treated Subgrade (Shoulders)	7 days	Mon 10/7/19	Tue 10/15/19	0 days	5-Day	Pozzolanic
34	6" Lime Cure Time	14 days	Wed 10/9/19	Tue 10/22/19	0 days	Calendar Day	Pozzolanic
35	Install 6" Underdrain & Cleanouts under Pavement	5 days	Wed 10/9/19	Tue 10/15/19	5 days	5-Day	Bunn Enterprises
53	CTPB Prep (Fabric + Stringline) - TW "Y"	5 days	Mon 10/14/19	Fri 10/18/19	62 days	5-Day	
36	Install 6" Underdrain & Cleanouts outside Shoulders	8 days	Wed 10/16/19	Fri 10/25/19	106 days	5-Day	Bunn Enterprises
54	Pave CTPB - TW "Y"	5 days	Wed 10/16/19	Tue 10/22/19	62 days	5-Day	
38	CTPB Prep (Fabric + Stringline)	15 days	Wed 10/23/19	Tue 11/12/19	0 days	5-Day	Harper
47	Install 2" PVC Conduit & Drains under TW "Y" Pavement	2 days	Wed 10/23/19	Thu 10/24/19	62 days	5-Day	Airfield Etc.
39	CTPB Pave	15 days	Fri 10/25/19	Thu 11/14/19	0 days	5-Day	Harper
37	Lay 6" P-219 or TDOT 303 on Shoulders - Lift #1	4 days	Mon 10/28/19	Thu 10/31/19	106 days	5-Day	Harper
42	Install Light Can Conduit under Shoulders	7 days	Fri 11/1/19	Mon 11/11/19	106 days	5-Day	Airfield Etc.
40	Install 2" PVC Conduit & Drains under Pavement	3 days	Fri 11/15/19	Tue 11/19/19	0 days	5-Day	Airfield Etc.
41	P-501 Prep	35 days	Wed 11/20/19	Thu 3/19/20	0 days	5-Day	Harper
62	Install & Backfill Electrical Manholes & Turf Cans	8 days	Wed 11/20/19	Tue 12/3/19	92 days	5-Day	Airfield Etc.
43	P-501 Pave	35 days	Fri 11/22/19	Mon 3/23/20	0 days	5-Day	Harper
44	P-501 Cure Time	150 days	Sat 11/23/19	Mon 4/20/20	35 days	Calendar Day	Harper
55	Joint Saw & Seal	10 days	Tue 3/31/20	Tue 4/14/20	38 days	5-Day	Harper
56	Pave P-401 Asphalt Pavement (4 LIFTS) - TW "Y"	5 days	Thu 4/2/20	Wed 4/8/20	0 days	5-Day	Rogers Group
51	Lay & Trim Final 6" P-219 or TDOT 303 Lift - All TW Shoulders	6 days	Thu 4/9/20	Fri 4/17/20	0 days	5-Day	Harper
50	Install Type B Shoulder Cans	8 days	Mon 4/20/20	Wed 4/29/20	0 days	5-Day	Airfield Etc.
63	Saw-Cut Grooving	10 days	Tue 4/21/20	Mon 5/4/20	24 days	5-Day	Harper
52	Asphalt Shoulder Paving	6 days	Thu 4/30/20	Thu 5/7/20	0 days	5-Day	Rogers Group
60	Saw & Seal Asphalt / PCC Joint	8 days	Fri 5/8/20	Tue 5/19/20	23 days	5-Day	Harper

ID	Task Name	Duration	Start	Finish	Total Slack	Task Calendar	Responsibility
64	Core & Raise Light Cans	8 days	Fri 5/8/20	Tue 5/19/20	0 days	5-Day	Airfield Etc.
65	Install TW Light Fixtures & Sealant	5 days	Mon 6/1/20	Fri 6/5/20	11 days	5-Day	Airfield Etc.
66	**TW "G" and "G4 Connector**	**161 days**	**Mon 8/12/19**	**Mon 6/8/20**	**6 days**	**5-Day**	
77	Electrical / NAVAID Work	53 days	Mon 8/12/19	Thu 10/24/19	0 days	5-Day	
78	Directional Bore across TW G FOT 17 - FOT-16 & Across Service Road	2 days	Mon 8/12/19	Tue 8/13/19	6 days	5-Day	
79	Install Duct Bank - FOT 16 to Existing Tie In	2 days	Wed 8/14/19	Thu 8/15/19	6 days	5-Day	
80	Install Duct Bank - FOT 17 to FOT 18 - CROSSES GAS MAIN	3 days	Mon 8/26/19	Wed 8/28/19	0 days	5-Day	
81	Install Duct Bank - FOT-18 to FOT-20	3 days	Thu 8/29/19	Tue 9/3/19	0 days	5-Day	
82	Install Duct Bank - FOT-20 to FOT-22	3 days	Wed 9/4/19	Fri 9/6/19	0 days	5-Day	
83	Install Duct Bank - FOT-22 to FOT-23	2 days	Mon 9/9/19	Tue 9/10/19	0 days	5-Day	
84	Install Duct Bank - FOT-23 to FOT-24	2 days	Wed 9/11/19	Thu 9/12/19	0 days	5-Day	
85	Install Duct Bank - FOT-24 to FOT-29	5 days	Fri 9/13/19	Thu 9/19/19	0 days	5-Day	
86	Install Duct Bank (LESS BORE) - FOT29 to FOT-30	3 days	Fri 9/20/19	Tue 9/24/19	0 days	5-Day	
87	Install Duct Bank - FOT-30 to FOT-31	1 day	Wed 9/25/19	Wed 9/25/19	0 days	5-Day	
88	Install Duct Bank - FOT-26 to FOT-27	2 days	Thu 9/26/19	Fri 9/27/19	0 days	5-Day	
89	Install Electrical Manholes & Tie In Duct Banks	10 days	Mon 9/30/19	Fri 10/11/19	0 days	5-Day	
91	Install Panels / NEMA Enclosures in ATCT Equip. Room	2 days	Mon 10/14/19	Tue 10/15/19	0 days	5-Day	
92	Install Panels / NEMA Enclosures in RT Equipment Shelter	2 days	Wed 10/16/19	Thu 10/17/19	0 days	5-Day	
90	Pull Fiber Optic Cable	3 days	Fri 10/18/19	Tue 10/22/19	0 days	5-Day	
93	Tie-In Fiber Optic / Tower Shutdown	1 day	Wed 10/23/19	Wed 10/23/19	0 days	5-Day	
94	Disconnect Existing (OLD) FAA Cables	1 day	Thu 10/24/19	Thu 10/24/19	0 days	5-Day	
67	Shut Down TW "G" at "G4"	1 day	Tue 8/20/19	Tue 8/20/19	0 days	5-Day	Airfield Etc.
68	Install Temporary Jumpers	1 day	Tue 8/20/19	Tue 8/20/19	0 days	5-Day	Airfield Etc.
69	**TW G / G4 Demo**	**24 days**	**Tue 8/20/19**	**Mon 9/23/19**	**1 day**	**5-Day**	
73	Sawcut Existing Concrete	2 days	Tue 8/20/19	Wed 8/21/19	25 days	5-Day	
70	Demo Electrical - Remove Fixtures, Cans, Cable, & Guidance Sign, Conduits	3 days	Wed 8/21/19	Fri 8/23/19	0 days	5-Day	
74	Break Existing Concrete (14-16"" DEEP)	5 days	Wed 8/21/19	Tue 8/27/19	25 days	5-Day	
75	Mill Existing Asphalt / Remove Stone Base	8 days	Mon 8/26/19	Thu 9/5/19	23 days	5-Day	
76	Remove Concrete & Base (16" PCC ON 9" CTB)	10 days	Mon 8/26/19	Mon 9/9/19	23 days	5-Day	
71	Unclassified Excavation	7 days	Tue 9/10/19	Wed 9/18/19	23 days	5-Day	
72	Trim Pre-Lime Subgrade	4 days	Wed 9/18/19	Mon 9/23/19	23 days	5-Day	



ID	Task Name	Duration	Start	Finish	Total Slack	Task Calendar	Responsibility
95	Remove Existing FAA Duct Bank & Base Material	2 days	Fri 10/25/19	Mon 10/28/19	21 days	5-Day	Airfield Etc.
96	Install Catch Basins & 30" RCP	5 days	Fri 10/25/19	Thu 10/31/19	111 days	5-Day	Harper
98	Install Electrical Duct Bank	3 days	Fri 10/25/19	Tue 10/29/19	0 days	5-Day	Airfield Etc.
100	Install & Backfill Electrical Manholes	2 days	Wed 10/30/19	Thu 10/31/19	81 days	5-Day	Airfield Etc.
102	12" Lime Stabilized Subgrade	8 days	Wed 10/30/19	Thu 11/7/19	0 days	6-Day	Pozzolanic
97	Remove Existing Storm Pipe (SAFELOADING?)	2 days	Fri 11/1/19	Mon 11/4/19	111 days	5-Day	Harper
99	Install Guidance Sign Foundations	7 days	Fri 11/1/19	Mon 11/11/19	81 days	5-Day	Airfield Etc.
103	12" Lime Cure Time	14 days	Fri 11/1/19	Thu 11/14/19	0 days	Calendar Day	Pozzolanic
104	6" Lime Stabilized Subgrade	5 days	Fri 11/8/19	Wed 11/13/19	2 days	6-Day	Pozzolanic
105	6" Lime Cure Time	10 days	Sun 11/10/19	Tue 11/19/19	2 days	Calendar Day	Pozzolanic
106	6" Underdrain - Under TW Pavement	2 days	Fri 11/15/19	Mon 11/18/19	0 days	5-Day	Bunn Enterprises
107	6" Underdrain - Under TW Shoulders	4 days	Tue 11/19/19	Fri 11/22/19	0 days	5-Day	Bunn Enterprises
108	Prep CTPB (Fabric & Stringline)	7 days	Mon 11/25/19	Thu 12/5/19	0 days	5-Day	Harper
114	Lay 6" P-219 / TDOT 303 on Shoulders - Lift #1	2 days	Mon 11/25/19	Tue 11/26/19	39 days	5-Day	Harper
109	Pave CTPB	7 days	Wed 11/27/19	Mon 12/9/19	0 days	5-Day	Harper
115	Install 2" Conduit for Base Cans on Shoulders	5 days	Wed 11/27/19	Thu 12/5/19	39 days	5-Day	Airfield Etc.
101	Install 2" PVC Conduit & Drains under Pavement	2 days	Tue 12/10/19	Wed 12/11/19	0 days	5-Day	Airfield Etc.
110	Prep P-501	19 days	Thu 12/12/19	Tue 3/17/20	0 days	5-Day	Harper
111	Install In-Pavement Light Cans	1 day	Thu 12/12/19	Thu 12/12/19	20 days	5-Day	Airfield Etc.
112	Pave P-501	19 days	Mon 12/16/19	Thu 3/19/20	0 days	5-Day	Harper
113	P-501 Cure Time	52 days	Tue 12/17/19	Thu 2/6/20	114 days	Calendar Day	Harper
120	Joint Saw & Seal	4 days	Thu 3/19/20	Tue 3/24/20	52 days	5-Day	Harper
116	Lay & Trim P-219 / TDOT 303 - Lift #2	5 days	Thu 4/9/20	Thu 4/16/20	0 days	5-Day	Harper
117	Install Shoulder Base Cans	9 days	Fri 4/17/20	Wed 4/29/20	0 days	5-Day	Airfield Etc.
118	Lay Asphalt Base Course	2 days	Thu 4/30/20	Fri 5/1/20	0 days	5-Day	Rogers Group
119	Lay Asphalt Surface Course	2 days	Mon 5/4/20	Tue 5/5/20	0 days	5-Day	Rogers Group
121	Saw & Seal Asphalt / PCC Joint	3 days	Wed 5/6/20	Fri 5/8/20	30 days	5-Day	Harper
122	Core & Raise Light Cans	10 days	Wed 5/6/20	Tue 5/19/20	0 days	5-Day	Airfield Etc.
123	Install LED Fixtures on TW G, G4 & Sealant	4 days	Mon 6/1/20	Thu 6/4/20	0 days	5-Day	Airfield Etc.
124	Install new Light Fixtures on Existing Cans (G4 & B6 Connector)	2 days	Fri 6/5/20	Mon 6/8/20	0 days	5-Day	Airfield Etc.
23	Crush Concrete for P-219	25 days	Tue 8/13/19	Tue 9/17/19	94 days	5-Day	Crush, LLC

August 20
16 21 26 31 5

ID	Task Name	Duration	Start	Finish	Total Slack	Task Calendar	Responsibility
129	Turf Shoulder Construction / Infield Grading	15 days	Fri 5/8/20	Fri 5/29/20	6 days	5-Day	Harper
126	Pull #8 5kV Cable through Circuit	7 days	Wed 5/20/20	Fri 5/29/20	0 days	5-Day	Airfield Etc.
127	Permanent Seed & Erosion Control	2 days	Mon 6/1/20	Tue 6/2/20	14 days	5-Day	Erosion Solutions
130	Final Cleanup/Sweeping	5 days	Tue 6/9/20	Mon 6/15/20	0 days	5-Day	Harper
125	Install Guidance Signs & Panels	5 days	Mon 6/15/20	Fri 6/19/20	1 day	5-Day	Airfield Etc.
128	Permanent Striping	4 days	Tue 6/16/20	Fri 6/19/20	0 days	5-Day	Speidel Construction, I
131	Remove Barricades	1 day	Mon 6/22/20	Mon 6/22/20	0 days	5-Day	Harper
132	**Project 4 Deadline**	**0 days**	**Mon 6/22/20**	**Mon 6/22/20**	**0 days**	**Calendar Day**	
133	**Project 4 Substantially Complete**	**0 days**	**Mon 6/22/20**	**Mon 6/22/20**	**0 days**	**5-Day**	

August 20
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able to health, safety, convenience and prosperity.

Such regulations may include requirements of the extent to which and the manner in which streets shall be graded and improved and water, sewer and other utility mains, piping, connections or other facilities shall be installed as a condition precedent to the approval of the plat. The regulations or practice of the planning commission may provide for the tentative approval of the plat previous to such improvements and installation; but any such tentative approval shall not be entered on the plat. Such regulations may provide that, in lieu of the completion of such work previous to the final approval of a plat, the commission may accept a bond, in an amount and with surety and conditions satisfactory to it, providing for and securing to the municipality the actual construction and installation of such improvements and utilities within a period specified by the planning commission and expressed in the bonds; and the municipality is hereby granted the power to enforce such bonds by all appropriate legal and equitable remedies. Such regulations may provide, in lieu of the completion of such work previous to the final approval of a plat, for an assessment or other method whereby the municipality is put in assured position to do said work and make said installations at the cost of the owners of the property within the subdivision.

Before adoption of its subdivision regulations or any amendment thereof, a public hearing thereon shall be held by the planning commission. (Ord. No. 280, Sec. 6)

14-107. **Approval or disapproval of subdivision plats.** The planning commission shall approve or disapprove a plat within thirty (30) days after the submission thereof; otherwise such plat shall be deemed to have been approved and a certificate to that effect shall be issued by the planning commission on demand; provided, however, that the applicant for the planning commission's approval may waive this requirement and consent to the extension of such period. The ground of disapproval of any plat shall be stated upon the records of the planning commission. Any plat submitted to the planning commission shall contain the name and address of a person to whom notice of hearing shall be sent; and no plat shall be acted upon by the planning commission without affording a hearing thereon, notice of the time and place of which shall be sent by mail to said address not less than five (5) days before the date fixed therefor. (Ord. No. 280, Sec. 7)

14-108. **Dedication of property.** The approval of a plat shall not be deemed to constitute or effect an acceptance by the municipality, county or public of the dedication of any street or other ground shown upon the plat. (Ord. No. 280 Sec. 8)

14-109. **Unlawful transactions involving subdivision plats.** Whoever, being the owner or agent of the owner of any land, transfers or sells or agrees to sell or negotiates to sell such land by reference to or exhibition of or by other use of a plat of subdivision of such land without having submitted a plat of such subdivision to the municipal planning commission and obtained its approval as required by this chapter and before such plat be recorded in the office of the county register, shall be deemed guilty of a misdemeanor. The municipality, through its attorney or other official designated by the Board of Commissioners may enjoin such transfer or sale or agreement by action for injunction. (Ord. No. 280, Sec. 9)

14-110. **Restrictions on public improvements.** From and after the time when the platting jurisdiction of the planning commission shall have attached as provided in Section 14-105, the municipality shall not nor shall any public authority accept, lay out, open, improve, grade, pave or light any street or lay or authorize water mains or sewers or connections to be laid in any street within the municipality, unless such street shall have been accepted or opened as or shall have otherwise received the legal status of a public street prior to the said attachment of the planning commission's subdivision jurisdiction, or unless such street correspond in its location and lines with a street shown on a subdivision plat approved by said planning commission or with a street plat made by and adopted by said planning commission; provided, however, that the board of commissioners may locate and construct or may accept any other street, provided, the ordinance or other measure of such location and construction or for such acceptance be first submitted to said planning commission for its approval, and, if disapproved by the planning commission be passed by a majority of the entire membership of said board of commissioners; and a street approved by the planning commission upon such submission or constructed or accepted by said majority vote after disapproval by the planning commission shall have the status of an approved street as fully as though it had been originally shown on a subdivision plat approved by the planning commission or on a plat made and adopted by the planning commission. (Ord. No. 280, Sec. 10)

14-111. Approval or disapproval of site plans. Site plans shall be required for all new developments, and/or redevelopments of all non single-family uses to ensure compliance with all city requirements. Such plans shall be approved by the planning commission prior to any land disturbance or the issuance of a grading or building permit. Pursuant to authority granted by *Tennessee Code Annotated*, § 13-3-413, site plans for any public use including, but not limited to, schools, parks, streets, public buildings and utilities shall be prepared in accordance with the provisions of this ordinance. Site plans shall expire one (1) year after planning commission approval if a grading permit has not been issued. If a building permit is not issued within one (1) year of grading permit issuance, the grading permit shall be rescinded. If a building permit or grading permit expires or is rescinded, the site plan shall also expire. Once the site plan has been implemented, the site shall remain in compliance with the approved site plan. Any variation from the approved site plan shall require the approval of an amendment to the site plan. All site plans shall be prepared and certified by a licensed engineer, landscape architect, architect and/or surveyor, as may be appropriate, and in accordance with state law regarding the practice of these professions. (As added by Ord. #14-323, Jan. 2014)

14-112. Approval or disapproval of exterior building design plans.

Before a building permit may be issued the planning commission (designated as the design review commission) shall review and either approve or disapprove exterior building elevations in compliance with minimum design standards. These standards established within the *Zoning Ordinance* apply to design of principal buildings and accessory structures constructed on all properties except for single-family detached, including any entrances to developments of the same, with an exemption for all uses within industrial or mixed industrial zones, as well as those for the principle purpose of conducting agricultural and livestock activities;

14-113. Establishment of vested property rights.

(1) The following list details the specified types of approvals, which establishes a vested property right, as set forth in *Tennessee Code Annotated,* Sections 13-3-413 and 13-4-310:

a. Approval of a development plan for a preliminary or final subdivision plat that satisfies overall subdivision requirements and development standards, which may include additional provisions for planned unit developments or other similar zoning districts;

b. Approval of a development plan for a single site that satisfies overall site plan requirements and development standards, which may include additional provisions for planned unit developments or other similar zoning districts;

c. Approval of a development plan for a special exception that may be granted by the Alcoa Board of Zoning Appeals; and,

d. Where there is no need for prior approval of a development plan, a vested right shall be established upon issuance of a building permit.

(2) During the vesting period, the locally adopted development standards which are in effect on the date of an approval shall remain the development standards applicable to that property during the vesting period as follows:

Type of Project	Effective Vesting Date	Vesting Period	Total Vesting Period to Maintain Vesting Rights	Required Actions
Building permit (no development plan required)	Date of issuance of building permit	Period authorized by the building permit	Period authorized by the building permit	Complete construction within period authorized by the building permit
Development plan:				
Development plan (Site preparation)	Date of issuance, upon meeting all city requirements and by stamped approval on plan	3 years	3 years	Obtain approval of a development plan; secure permits; and, commence site preparation
Development plan (Construction)	3 years from the approval date	2 years	5 years	Commence construction and maintain permits
	5 years from the approval date	5 years	10 years	Complete construction and maintain permits
Multi-phase (2 or more sections or phases)	Date of issuance from the initial approval date	Separate vesting period for each phase or section	15 years	Complete construction for each section or phase and maintain permits

Please note that plans may be subject to review and approval by the Alcoa Board of Zoning Appeals or the Alcoa Board of Commissioners. (As added by Ord. #15-351, June 2015)

14-114. __**Restrictions on building permits and building construction.**__ From and after the time when the platting jurisdiction planning commission shall have attached as provided in Section 14-105, no building permit shall be issued for or no building shall be erected on any lot within the municipality, unless the street giving access to the lot upon which said building is proposed to be placed shall have been accepted or opened as or shall have otherwise received the legal status of a public street prior to that time or unless such street corresponds in its location and lines with a street shown on a subdivision plat approved by said planning commission or on a street plat made and adopted by said planning commission, or with a street located or accepted by the board of commissioners after submission to said planning commission and, in case of said planning commission's disapproval, by the favorable vote required in Section 14-110. Any building erected or to be erected in violation of this section shall be deemed an unlawful structure, and the building inspector or attorney of the municipality or other official designated by the board of commissioners may bring action to enjoin such erection or cause it to be vacated or removed. (Ord. No. 280, Sec. 11)

14-115. **Definitions.** For the purpose of this chapter, certain terms and words are herein defined as follows:

(1) "Applicant" means the owner of land proposed to be developed and/or subdivided or their representative(s) who shall have express written authority to act on behalf of the owner. Consent shall be required from the legal owner of the premises.

(2) "Concept plan" means a generalized plan indicating the property boundaries for development of a subdivision or single site and identifies proposed land use, land use intensity and thoroughfare alignment, and other necessary features, to reach a general agreement with the planning commission as to the form of the plan and the objectives of subdivision and/or site plan development regulations, prior to review and approval of a development plan.

(3) "Development plan" means a plan for the development of a subdivision or single site describing with reasonable certainty the legal boundaries, existing conditions (to include significant topological features), type, proposed layout and intensity of use, as well as the detailed development design for commencing site preparation and construction built to meet all locally adopted and enforced subdivision and site plan requirements and development standards. Such plan may be in the form of, but not limited to:

a. a subdivision plat that includes on and/or off-site civil engineering de sign and utility infrastructure;

b. a site plan that includes on and/or off-site civil engineering design and utility infrastructure;

c. a planned unit development, or other similar zoning district, that includes on and/or off-site civil engineering design and utility infrastructure; and,

d. any other land-use approval that may require review and approval by the Alcoa Board of Zoning Appeals or Alcoa Board of Commissioners.

An approval shall be issued for such a plan, upon meeting all city requirements and by stamped approval on the plan. A plan that fails to describe with reasonable certainty the use and detailed development design of a property shall not be issued an approval.

(4) "Development standards" means all locally adopted or enforced standards, regulations or guidelines applicable to the development of property, including, but not limited to, planning (zoning and land use controls and subdivision requirements for improvements related to the layout and building configuration, vehicular and pedestrian circulation, landscaping and any other similar on/off-site improvements); detailed civil and electrical engineering design (storm water management, on/off-site layout and roadway improvements and all related public and/or private utility infrastructure); and, buildings and other similar structures, in which an applicant may require vested rights or vested property rights. Standards required by federal or state law, or building construction safety codes, are not included.

(5) "Single site" means the development of a single tract, parcel or lot, irrespective of subdivision development.

(6) "Street" or "streets" means and includes streets, avenues, boulevards, roads, lanes, alleys and other ways;

(7) "Subdivision" means the division of a tract or parcel of land into one, two or more lots, sites, or other divisions for the purpose, whether immediate or future, of sale or building development, and includes re-subdivision and when appropriate to the context, relates to the process of subdividing or the land or area subdivided. (Ord. No. 280, Sec. 12, as amended by Ord. #15-351, June 2015)

f. Drainage plan with calculations for increased run off;

g. Existing and proposed tree locations in accordance with Sub-Chapter 2.17 of this zoning ordinance.

h. Additional information on soil, geologic and other conditions may be required;

i. The means of preserving and maintaining the common open space shall be assured as a part of the development.

14-2.1803. **Height of building.** No building shall be erected or structurally altered to exceed 2 ½ stories or 35 feet in height; except that churches, schools and other public buildings may be erected to a height of 60 feet or four (4) stories provided each yard required herein is increased an additional one (1) foot for each foot in height such building exceeds 35 feet. On a lot less than 75 feet in width at the building line, no building shall exceed 2 ½ stories or 35 feet in height.

14-2.1804. **Front yard.** There shall be a front yard of not less than 30 feet in width. If located on one of the adopted corridors, the front yard shall not be less than that required (see Ordinance #98-014 and #98-015).

14-2.1805. **Side yard.** There shall be a side yard of not less than ten (10) feet in width.

14-2.1806. **Rear yard.** There shall be a rear yard of not less than 35 feet.

14-2.1807. **Lot area and maximum lot coverage.** The minimum land area shall be 15,000 square feet (with public sewer and water available), 25,000 square feet (with public water alone), and 30,000 square feet (with neither public water nor sewer available). The maximum building area shall not exceed 30% of the total lot area.

corner. The postguards shall meet the minimum width of clearance. All dumpster pads shall be approved by the City of Alcoa Public Works and Engineering Department prior to construction (See Dumpster Pad Specifications).

14-2.2107. <u>Future street lines</u>.

(1) For the purpose of providing adequate open space between buildings on lots located on major streets, future street lines are hereby established as shown on the Zone Map of Alcoa and are adopted as part of this ordinance.

(2) On any lot which would be reduced in area by widening a public street to a future street line shown on the Zone Map of Alcoa, the minimum required yards, the minimum required lot area, and the minimum required lot width, and the maximum building area shall be measured by considering the future street lines as the lot lines of such lot. (Ord. No. 338, Sec. 13 (G), as amended by Ord. No. 09-189).

14-2.2108. <u>Driveway entrances</u>.

(1) General provisions. It shall be unlawful for any person to cut, break out or remove any curb along a street or to construct a driveway onto a street except as authorized by this ordinance and by obtaining a building permit to do the same. No driveway approach shall interfere with municipal facilities such as street lighting poles, traffic signals standards, sign, catch basins, hydrants, crosswalks, bus loading platforms, utility poles or other necessary street structures. Where curbing is removed for the construction of a driveway, it shall be repaired at the gutter lines and edges of exposed curbing shall be returned to a smooth finish. Where no curbing exists a drain pipe of a size approved by the Building Inspector shall be installed at the ditch line. This pipe shall be furnished and installed by the person constructing the driveway. For driveway entrances to residences the width of the driveway shall not be less than ten (10) feet on minor and local roads and 15 feet on collector and arterial roads. The maximum width shall not be more than 20 feet. This width shall be measured along the outside sidewalk line, or where no sidewalk exists, a line in the street right-of-way parallel to and four (4) feet from the line of the property. Residential driveways shall be a minimum distance of five (5) feet from the property line and all residential driveways accessing a collector or arterial road shall have included as a part of the overall design an area sufficient to allow a passenger vehicle to turn around in order to eliminate the need to back from the driveway onto the roadway. For driveway entrances to business or industrial establishments, the width of the driveway shall meet a minimum width of 36 feet, unless approved by the planning commission. This width shall be determined by measuring along the outside sidewalk line, or where no sidewalk exists, a line in the street right-of-way line parallel to and four (4) feet from the line of the property. The maximum allowable grade for any driveway shall be eight (8) percent, unless otherwise approved by the City Engineer. Where more than one driveway approach on a street front serves a residential property (i.e., circular drives), the planning commission must approve the distance between approaches. The sides, edges, or curbs of driveway approaches shall be at right angles to the street. The radius of curvature of the curb return shall not exceed the distance between the curb and outside sidewalk line; or, if no sidewalk exists, a line in the right-of-way parallel to and four (4) feet from the property line. No portion of a driveway approach, except the curb return, shall be constructed within 18 feet from the point of intersection of the lines of the two street curb faces extended into the street intersection. No part of the driveway, including curb returns, shall extend beyond the property line projected.

(2) Access control standards in commercial districts.

a. In all commercial districts the distance between access points to a public street shall be no less as set forth in the following table:

Classification of Street	Distance between

arrows and the like to assist public circulation into, on, and out of the property and through parking lot areas.

f. Where, in the opinion of the Planning Commission, topographical or other physical features make the construction of circulation drives and/or frontage roads infeasible, the Planning Commission may determine the number and width of access points to a particular property in accordance with the following table:

Lot Frontage	Maximum Number of Access Points	Maximum Width of Access Points
Less than 75 ft.	1	30 ft.
75 ft. – 149 ft.	1a	30 ft. a
150 ft. – 299 ft.	2	30 ft.
Each additional 300 ft.	1b	30 ft.

(a.) Gasoline service stations may have 2 access points.

(b.) Or as determined by the Planning Commission.

g. A building permit for any property in a commercial district shall not be issued until the Planning Commission for the City has reviewed and approved all plans and specifications for proposed access points. Said plans and specifications shall include site plans, construction plans, and elevations drawn to a scale of not less than one (1) inch equals fifty (50) feet, showing proposed access points, drives, walks, circulation, parking spaces, loading facilities, landscaping, planting materials, structures, buildings, uses, heights, setbacks, and any additional information required by the City. Such plans shall conform to the City Plan for access and traffic control. No regular certificate of occupancy shall be issued for any use or activity within a commercial district until all access control provisions, as outlined in this section, have been met. (Ord. No. 338, Sec.13, as amended by Ord. No. 365, Sec. 2, and Ord. No. 643)

14-2.2109. Sidewalks and other pedestrian facilities. To promote alternative modes of transportation and contribute to a safe, healthy and viable city environment, pedestrian access shall be provided to and from all lots developed for both non-residential and residential multi-family uses. Provisions are as follows:

(1) Sidewalks: Where new construction or the redevelopment of a site necessitates a site plan review by the Planning Commission, sidewalks shall be constructed within the right-of way of all public street frontages where pedestrian traffic is permissible, except as follows:

a. In instances where the construction of sidewalks is inappropriate or otherwise unfeasible at the time of development or redevelopment, as determined by the Planning Commission, a contribution to the City sidewalk fund in an amount equivalent to the cost of sidewalk construction shall be required; and,

b. In instances where the development is adjacent to an existing greenway or has the potential for a connection to an existing or planned greenway, the Planning Commission at their discretion may require the construction of a greenway or other appropriate pedestrian facility on either right-of–way or easement granted to the City in lieu of sidewalk construction.

c. cornices and moldings;
d. wall arches;
e. wall and structural columns and/or pilasters;
f. enhanced entry doorways, projected or recessed;
g. enhanced window treatments;
h. distinct textural changes in construction materials (integrating a combination of brick, stone, cast stone, stucco and wood or wood substitute are preferred); and,
i. any other similar decorative accent or broader feature that may be reviewed for consideration.

(2) The glass area of all exterior windows shall be calculated to total a minimum of five percent (5%) of the total wall area visible from a public roadway.

(3) Designers shall incorporate notable architecture accents and broader features in their overall building design, providing for compatibility with surrounding structures and thematic expression. Visual cues may include the combined use of brick, cornicing and arch work found in many of the City's past and present institutional buildings, which nod subtly to the historical role of Alcoa, Inc. Stacked stone, trellises, tapered columns and other rustic accents found in public spaces of Pellissippi Place are other visual cues to consider. A few prominent examples have been included below (see figures 3A-3D).

Exterior walls visible from a public roadway shall not be comprised of exposed metal or flat-faced concrete block. However, metal accents or broader features of the same may be considered. Note that changes in paint color, color bands, flat tiles, narrow trim accents (less than 12 inches) and shutters shall not be considered architectural accents or broader features.

Figure 3A

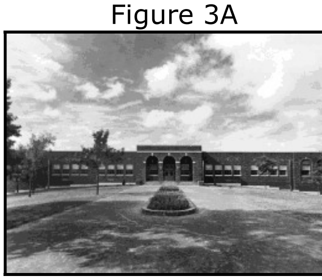


Figure 3B

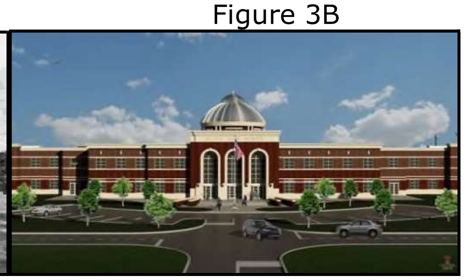


Figure 3C

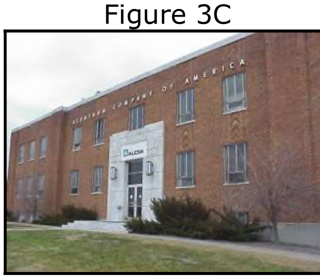
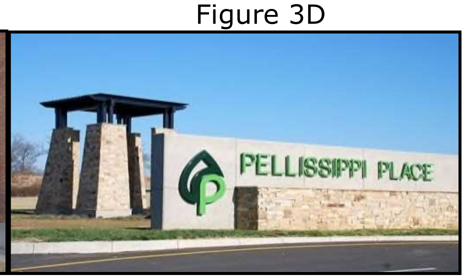


Figure 3D



(As added by Ord. #15-355, Sept. 2015)

14-2.2111. **Exterior lighting.** To reduce the production of light pollution that may encroach onto adjacent properties, pole lighting and other related fixtures shall be designed to project light downward. Accent lighting fixtures that may be used on a building, sign structure or within the landscape shall be aimed or directed to preclude light projection beyond immediate objects intended to be illuminated. (As added by Ord. #15-356, Sept. 2015)

14-2.2112. Underground utilities. All utilities including, but not limited to, electrical power, telephone, television and internet cable, fiber optics and other such facilities shall be installed underground, unless, in the opinion of the planning commission, special conditions require otherwise. (As added by Ord. #15-356, Sept. 2015)

14-2.2113. Flood damage prevention regulations.

(1) Statutory Authorization, Findings of Fact, Purpose and Objectives:

a. Statutory Authorization.

The Legislature of the State of Tennessee has in Tennessee Code Annotated, Sections 13-7-201 through 13-7-210, delegated the responsibility to units of local government to adopt regulations designed to promote the public health, safety, and general welfare of its citizenry. Therefore, the Alcoa, Tennessee Mayor and Board of Commissioners, does ordain as follows:

b. Findings of Fact.

1. The Alcoa Mayor and Board of Commissioners wishes to establish eligibility in the National Flood Insurance Program and in order to do so must meet the requirements of 60.3 of the Federal Insurance Administration Regulations found at 44 CFR Ch. 1 (10-1-04 Edition) and subsequent amendments;

2. Areas of Alcoa are subject to periodic inundation which could result in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impairment of the tax base, all of which adversely affect the public health, safety and general welfare; and,

3. These flood losses are caused by the cumulative effect of obstructions in floodplains, causing increases in flood heights and velocities; and by uses in flood hazard areas which are vulnerable to floods; or construction which is inadequately elevated, flood-proofed, or otherwise unprotected from flood damages.

c. Statement of Purpose.

It is the purpose of this Ordinance to promote the public health, safety and general welfare, and to minimize public and private losses due to flood conditions in specific areas. This Ordinance is designed to:

1. Restrict or prohibit uses which are vulnerable to water or erosion hazards, or which cause damaging increases in erosion, flood heights, or velocities;

2. Require that uses vulnerable to floods, including community facilities, be protected against flood damage at the time of initial construction;

3. Control the alteration of natural floodplains, stream channels and natural protective barriers, which are involved in the accommodation of flood waters;

4. Control filling, grading, dredging and other development which may increase erosion or flood damage, and;

5. Prevent or regulate the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards, to other lands.

d. Objectives.

The objectives of this Ordinance are:

1. To protect human life, health and property;

2. To minimize expenditure of public funds for costly flood control projects;

3. To minimize the need for rescue and relief efforts associated with flooding and generally undertaken at the expense of the general public;